RAILWAY ENGINEERING AND MAINTENANCE OF WAY.

WITH WHICH IS INCORPORATED

ROADMASTER AND FOREMAN

BRIDGES--BUILDINGS--CONTRACTING--SIGNALING--TRACK

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The Rock Island Receivership

On April 16 Judge George A. Carpenter of the United States District Court of Chicago appointed Judge Jacob M. Dickinson, formerly Secretary of War, and H. U. Mudge, receivers of the Chicago, Rock Island and Pacific Railway Company. The object of this receivership is to eliminate the possibilty of further loading down of the property with issues of unnecessary and speculative securities and an endeavor to protect the minority security holder against the unfair distribution of dividends and profits to the favored holders of the present overissues of securities. This receivership can therefore be classed as one brought about by "high and illegal financing," and is in no wise a reflection on the operation of the property. With three men of such high standing and integrity in charge of the finances there is no question about the interests involved being well looked after. An unique feature of the Rock Island company is the fact that the dividends were not earned last year on the basic stock, or the stock of the original company before the unnecessary expansion. This was brought about by the fact that wages, taxes, and material had increased and freight rates decreased to such an extent that the resultant cost of transportation reduced the net earnings below the dividend paying level, notwithstanding the fact that the gross earnings were greater than the year previous.

The Personnel of the Interstate Commerce Commission

We have called attention to the fact in several recent issues that it was high time to not only increase the number on the Interstate Commerce Commission but to change the personnel and appoint expert traffic, operating and engineering men in lieu of having the entire commission consist of lawyers and politicians. The reason for our taking this stand was principally due to the fact that the powers of the commission seem to be on the increase and they are delving more and more into operating and engineering details, which require the knowledge of experts to render proper decisions. We naturally side with the railways in this contention as several of the executives, within the past few months, realizing that regulation has come to stay, have expressed a desire that this be conducted by a commission that was composed of men thoroughly acquainted with the subject due to actual railway experience. A few days since we were much interested to hear a prominent shipper state also that the personnel of the commission should be changed, and experts placed upon it. This shipper handles over 2,000 cars per annum in and out of his plant and is thoroughly acquainted with the commission and its rulings. It has been suggested recently by able writers that a Secretary of Transportation should be embodied in the cabinet of the President. The only remarkable thing about this is the fact that it has not been done before, for it seems strange that the second largest industry in the country is not represented in the cabinet notwithstanding all the others are.

The Wage Arbitration of the Western Lines

On April 30 the Arbitration Board on the increase of wages to enginemen and trainmen of the Western railways, that is the lines west of Chicago, rendered their decision, this being the last day under the law a decision or disagreement could be rendered. This board has been in session since November last. The board naturally did not grant all the demands of the employees as a great many of these were beyond reason and verged on the preposterous. But increases were granted in some instances as high as 15 per cent, which will mean an additional expense to the railways involved of $5,000,000 per annum. The demands of the employees if allowed in toto would have meant an additional expense of over $40,000,000. The labor associations involved have heretofore been conceded to have been the most representative and conservative of all the labor organizations. But it seems to us their actions during the sessions of this board have forfeited all claim to this consideration. They misconstrued, controverted and exaggerated facts on numerous occasions. In their exhibits of points at issue numerous excerpts from publications were shown and in nearly every case only that portion was shown which could be construed as a help to the labor demands, other portions of the same article that refuted these claims were purposely obliterated. We called attention to the fact, several issues ago, that serious objection was being made by the labor interest to the "surprise" or "checking tests" being used by the railway companies. It seems to us that the labor organizations should welcome and approve of this as it should be as much to their interests as to the employer to discover and anticipate the man who, through carelessness, will wantonly destroy valuable property and, worse still, the lives of perfectly innocent people, consisting of both employees and the traveling public. It is the old story, the labor interests are like all so-called reformers, they seem to overlook and obliterate the most important factor of the equation —human nature. The railway official never overlooks this and in the form of the "human equation" is constantly on the alert for it and endeavoring to throw the most stringent safeguards around it. Witness the two railway accidents, mentioned elsewhere, that happened during the sessions of the board. The labor interests again lowered both their dignity and their prestige, after the board's decision was rendered, by threatening proceedings and Congressional investigations against one of the members, ex-Secretary of the Interior Nagel. It would take more than the biased representatives of labor interests, of restricted representation, to hurt a man of such unimpeachable character. The President so far has most dignifiedly declined to be drawn into the imbroglio. There was plenty of opportunity for labor to object to his appointment or to raise any question it desired regarding his eligibility during the sessions, but they did not do so. It is a "cry baby" act. The American public is erratic and too emotional at times, but in the long run it is eminently fair, and we prophesy, when it is educated to the exact status of affairs, that the labor interests, in this case, will not get the support from it that is essential for the success of anything in this country.

Automatic Train Control

The accident at Devon, Conn., on the New York, New Haven & Hartford on March 23 and at Ilon, England, on the Great Eastern on January 1, are extremely interesting examples of the fact that the "human equation" has neither been obliterated or brought under complete control in the operation of railways, either in this country or abroad. We have had comparative freedom for a few months in this country from disastrous wrecks, but this is largely due to a decreased traffic. Our observation of years, is that accidents vary in an adverse ratio with the amount of traffic—or, at least, the possibility of them does—that is double the traffic and the accidents will quadruple. The railway official is constantly on the alert for the "human equation" and has "safety first" ever uppermost in his mind, and when traffic is lessened is better able to get into actual personal touch with the individual and more vividly impress the doctrine of alertness. Therefore, when accidents occur under the most favorable conditions, it is a demonstration of the fact that the methods of discipline, instruction and surveillance are wrong and cannot be depended on in individual cases. There seems to be only one remedy and that it is take the control out of the hands of the "human individual" and place it in the hands of a cold, calculating automatic machine. There are automatic train controls manufactured that fulfill the R. S. A. specifications and the requirements of the old Board of Train Control. It is important that these devices be taken up more actively and installed with greater speed, particularly on railways of dense passenger traffic. It seems to us that the automatic train control is in the same position that the automatic block signal was twenty years ago—looked at askance by the railway official. If the standard train controls that are now being manufactured were installed more largely the railway official will find they are thoroughly practical.

RAILWAY CONSTRUCTION.

The Alabama, Tennessee & Northern is planning to start work soon on the extension projected last year from the present northern terminus at Reform, Ala., north for about 70 miles to a connection with the Illinois Central.

The Atlantic Coast Line, it is said, has made survey and is expected to begin construction soon on extension of the Haines City branch from Sebring, Fla., towards Lake Okeechobee.

The Arkansas Valley Interurban will start grading in a few days on its 22-mile extension from Halsted, Kan., to Hutchinson.

The Brule Grand Prairie & Peace River has applied for a charter to construct a railway from Brule Lake north to Grand Prairie, thence to a junction with the Pacific Great Eastern Ry., in the Peace river section; also to build a branch from Grand Prairie crossing to Peace river near Dunvegan, Alta., to a junction with the projected Pacific Peace River & Athabasca at the Montagneuse river.

The Physical Valuation of the Railways

An Account Giving Graphic Chart of Construction Cost and Also Detail Formation of Various Valuation Corps.

H. H. Edgerton, Jr.

The Interstate Commerce Commission is asking in what form should their valuation reports be made up to submit to Congress and to the public. In this respect a graphic chart should be part of the information required, as well as the cost per mile and the total cost of the whole road. In this issue will be found a sample of a graphic chart showing the cost of the important items given in millions of dollars, and divided into eight yearly periods, the time it took to construct the road and put it in operation. While this chart is taken from the valuation results of a certain road, the name of the road is withheld, and the amounts of money in millions of dollars shoved up, yet the relative positions of the items, right of way, grading, track equipment, etc., remains unchanged and graphically shows the relative values of these items as they actually occur in one prominent railway system of this country without exaggeration.

Referring to this chart, the relative position of some of these items will be a surprise even to the experienced. For instance, the item of grading always appeals to either an engineer or a layman, as one of the big items, yet when scaled off and put in position with the other expenses on a chart it is only the beginning. In this illustration of a charted valuation the size was necessarily so small that many items had to be merged with others or there would result in a confusion of lines. For instance, the item of track, covers fastenings, switches, frogs, interlocking, etc. The item "shops" covers machine shops proper, depots, buildings, water stations, coaling stations, etc., and as usual the item "legal expenses" covers a multitude of sins, but money was paid, and like the necessary evil that it is, it has to be accounted for, and given its relative position among the other costs—a by-gone that can only be regretted and charged up.

It is absurd to state a railroad's valuation as the creation of a day or a night. Nothing was created in relation to this subject in that time, not even the Congressional valuation act. Railroads all took time to build, and this time cost interest on the money that was tied up idle, waiting for the transportation route to be opened. Probably the fathers of the valuation bill only had in mind the grading and the right of way, and they and other theorists who fancied the railroads are over capitalized will be surprised to find what huge sums were required to keep afloat the enterprise during its construction period. That this item often equals or exceeds the grading will be found by looking at the chart. What a difference there would have been had it been possible to create a railroad with the waft of a fairy wand—over night, in a month, or even in a single year—then the politicians' ideals would have been correct, and engineers' pay brought to a minimum; as it is the poor engineer's emoluments amount to only a thin ribbon at the bottom.

In all railroad valuations the time it took to build plays a very important part. Certain expenses cannot be cut off but keep going on, and the interest on the money is ever with us, so that the first information a valuation engineer needs to know is how long did it take to build. In this respect there are two views as to how long a time a road may be said to be under construction.

First, until all construction proper ceases.

Second, until operating revenues pay interest on bonds.

Both of these are extreme cases, for construction hardly ever ceases (there is always something new being built), and some roads never did pay interest on the bonds. The White Pass and Yukon paid a dividend when half built and the Northern Pacific went into the hands of a receiver until the country got settled up with people to produce traffic. But as a general thing a preliminary period of two years or so when the road was organizing and purchasing right of way, and a construction period of from two to six years when the road was grading, can reasonably be determined and interest and other expenses allowed on the investment for those years.

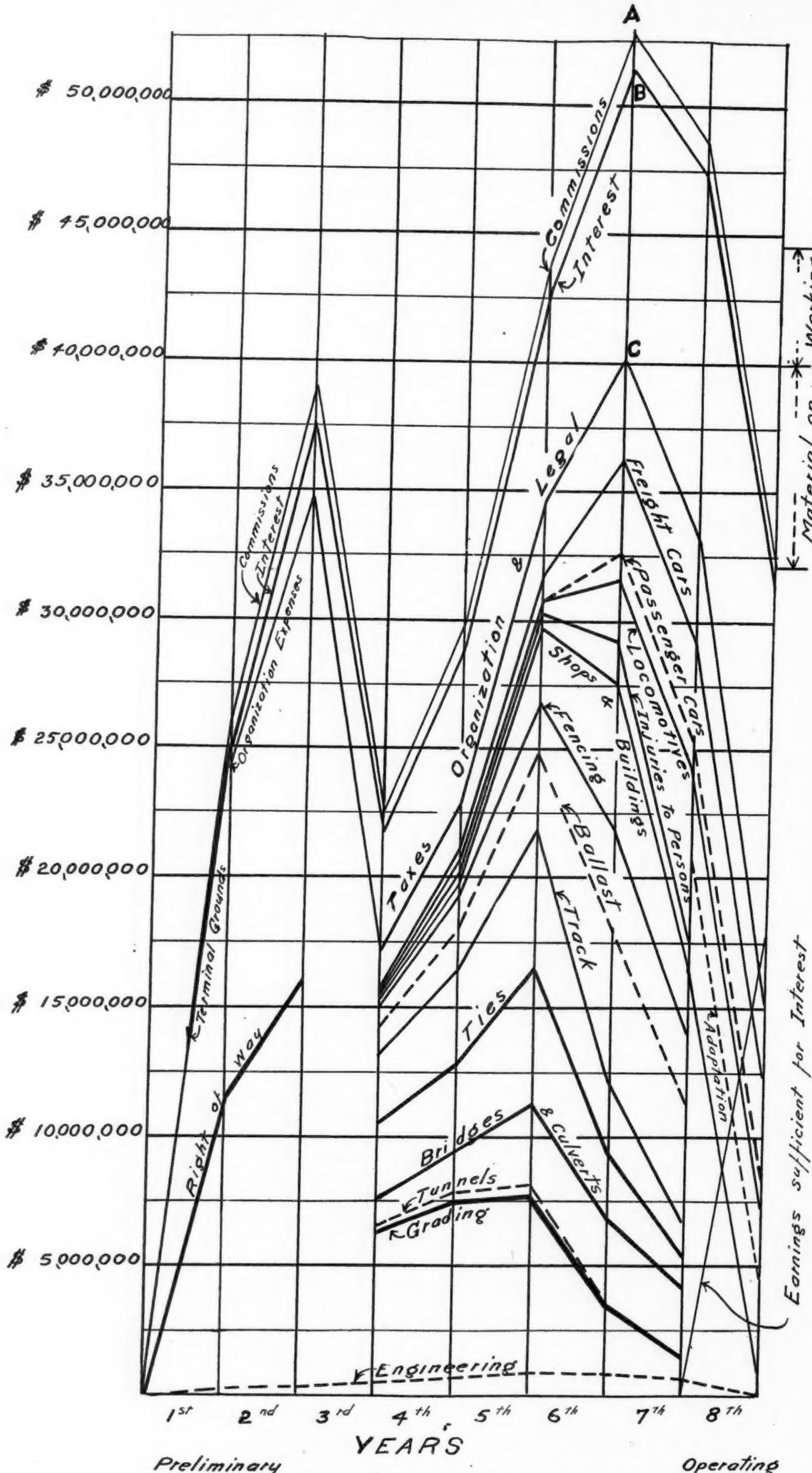
It will be noted that this typical road required eight years, and that the chart is divided accordingly. That this term of eight years is portioned off into a preliminary period of two years, a construction period of five years, and an operating period of one year, when the road became a full fledged transportation plant launched on the troubled sea of making ends meet. Also that the right of way purchasing ended at the end of the second year when the grading began, but this sudden chopping off of the one and the beginning of the other will not always occur for the eastern sections of some roads were well graded before the alignment of the western end was decided upon or any right of way out there purchased. At the end of the sixth year the commission charges were the highest, for the road was then carrying its greatest burden of interest, had reached its most delicate period of financing with no money coming in from train service, so larger amounts had to be paid to obtain the money needed. In this respect the chart may deceive a casual observer. It does not mean to state that these commissions were some $52,000,000, but should be measured from "A" to "B," the interest from "B" to "C." The lines of items on the chart are totals one upon another scaled from the bottom up.

THE WORKING ORGANIZATION OF A VALUATION FORCE.

GENERAL.

To give an actual case of a working organization of a valuation force, the following statement was obtained from a road in the central states. The management of the road asked that the name be withheld. We will say, however, that it is not the same road the chart of which has just been under consideration, the work on which road has been practically completed.

The extent and character of such organization depend on many factors; among which may be mentioned the magnitude of the work; density of population; whether the line passes through large cities and valuable property, or through sparsely settled country and deserts; on the length of the line; on the amount of already existing records, such as right of way and land maps, terminal maps, profiles, bridge records, building records, signal records, etc.; whether or not the valuation engineer can get material assistance from the land department, bridge engineers, signal engineers and the mechanical department. It is often a question whether it is better to put a single strong party in the field to gather all the necessary information, or to separate the work, having one party obtain certain general outlines of information, and have other parties obtain specific information as to own-



Graphic Chart Showing Cost, In Millions of Dollars, of Constructing a Railway and Putting It Into Operation.

ership of land, bridge data, signal data, etc., and the solution of all such questions depends upon the personnel of the forces available and the convenience or inconvenience of getting over the line and subsisting along the line.

In some cases it is almost imperative that one or more draftsmen accompany the field parties, and in other cases this work may be done entirely in the office; in some cases complete camp cars and the furnishing of both food and water from distant points is necessary; in other cases transportation by regular passenger trains and subsistence at hotels and boarding houses are found most economical. There is, however, a certain advantage in having a camp, which warrants some extra expense and trouble, but usually it is cheaper, more economical and more efficient.

Whether parties should be required to work at considerable distance from their camp or boarding house, using hand or gasoline cars, is usually worthy of consideration, and depends largely upon the density of population of the territory and upon the density of traffic on the road.

FIELD ORGANIZATION.

The field work of a parent company east of the Mississippi river, consisting of 3,200 miles, was made to supplement office plans and records, and largely consisted of chaining to locate all items noted. Cross-sections were taken at such intervals as were deemed necessary by the engineer in the field, and notes taken regarding such items as bridges, crossings and signs, fencing, as well as for frogs and switches and composition of track at such places were required for lack of record. Approximately half of the above work consisted in cross-sectioning. Additional field men were employed in getting records of sales and assessments at various county seats.

The normal size of parties on this work was as follows:

1 assistant engineer.
1 instrument man.
2 rod men.

The number of land men varied from 1 to 4 at averaging two men for the entire period of about 10 months.

All men above listed were paid traveling expenses and living expenses. The above parties subsisted by living at hotels, farm houses, etc.

Owing to the fact that the office work was not kept up with the field work, some difficulty was experienced later on account of information being lacking. The entire force consisted of 12 men for a period of 13½ months.

N. M. L. (A SUBSIDIARY LINE).

On this line, with a mileage of 1,500 miles, the field work was done by parties living in camp cars, and except where recent plans of stations, etc., gave the information, a complete resurvey was made, including chaining, running curves, levels, cross-sections (which were made out to the limits of the right of way, usually 100 feet on each side), location of station buildings, bridges, fuel and water stations, crossings, signs, signals, telegraph poles, fences, etc., also taking complete information as to rails, ties, frogs, switches, ballast, classification of material in cuts and fills. Detail measurements of buildings were taken, both inside and outside, which were supplemented with photographs where necessary.

For this purpose the normal parties consisted of:—

1 assistant engineer,
1 transitman,
1 draftsman or recorder,
1 levelman,
2 rodmen,
2 chainmen,
1 cook.

In addition to the above, fieldmen were employed, as in the case of the parent company, to obtain information from county records as to the sales and assessments of lands.

H. I. J. (A SUBSIDIARY LINE).

On this line, with a mileage of 4,300 miles, the field work was done by an organization ranging from 9 to 14 parties in number, and extending over a period of 24 months. The normal size of the parties was as follows:—

1 assistant engineer in charge,
2 chainmen,
1 rodman,
1 man who acted as levelman,
1 man who was classed as instrumentman, but whose —duty largely consisted in compiling notes in the field, the alignment and profiles and other information of record, making this possible.

On heavy work more men were added to the party, and, where necessary, outfit cars were furnished; also a cook, and sometimes an extra utility man. Parties not having camp outfits used local train transportation where possible. Hand cars and speeders were used to considerable extent. On some portions of the line the party was utilized to get considerable information about adjoining lands.

O. P. Q. (A SUBSIDIARY LINE).

This line, with a mileage of 348 miles, is of recent construction, and records of construction, with field notes, cross-sections, profiles, etc., were available, making very little field work necessary. Where such was required, it was done by the regular maintenance of way department force, adding to this force when necessary.

H. I. J. (ATLANTIC SYSTEM—A SUBSIDIARY).

On the 560 miles of the H. I. J. the field party consisted of:—

1 division engineer in charge, accompanying the party throughout,
1 transitman,
1 levelman,
2 draftsmen,
3 chainmen with transit party,
2 rodmen with level party,
1 cook.

This party was supplied with two camp cars, one water car and two hand cars. They were furnished with blueprints of station plans, track charts, a complete set of valuation forms, copy of side track records, profiles and right of way and alignments maps.

This party measured the main line continuously; width of right of way; all physical features on the right of way, such as buildings, bridges, culverts, switch points, frogs, crossing frogs, etc., and made an inventory of all material in spurs and siding. This information was platted in the field in specially prepared note books, to the scale of 100 feet to the inch. Progress of this party was about two miles a day.

Complete bridge, building, interlocking and telegraph line information being in the office, only such field work as was necessary to locate the same was taken in the field.

CENTRAL LINES (A SUBSIDIARY LINE).

On the central lines, consisting of 912 miles, the system of segregating the work was followed. A small party was sent out to get general information regarding bridges and culverts, buildings, foundations and soundings; telegraph lines and signals were each handled by a separate party.

The party taking general information consisted of:—

1 engineer,
4 rodmen,
1 instrumentman,

and this party generally took care of 200 miles of track.

This party made complete survey notes of the property, re-chained and re-stationed main track, and measured and sketched all other tracks. They took plan measurements only of all structures, sketching in their topography books the location of these, and noted also the location and dimensions of all other topographical features. Station pluses to land lines were taken to only such property lines as were well known and easily identified by the engineer, without delay to the survey work. Pluses to and general dimensions only of bridges, culverts and other structures were taken, while the detail information and sketches were left to the special parties engaged on the several other classes of work. Levels were taken on the top of rail at each station and cross-sections on each side of track, where necessary.

The special bridge and culvert party consisted usually of three men, headed by a man familiar with bridge construction and capable of sketching details of bridges, masonry and culverts. They checked carefully all existing plans against actual structures, and noted carefully all discrepancies, and field sketches, together with any additional features, such as rip-rap, and other protection work, as well as changes of channels, etc., from Mile 0 to Mile 231. Where no complete plans of these structures were on file, these special parties made clear sketches and took sufficient measurements to enable them to prepare complete plans and bills of material.

In a great many cases plans of bridges and culverts on file in the Chief Engineer's office showed data on foundations which did not appear to be correct, or was inaccurate, and it was, therefore, decided to organize a gang to go back over the line and make soundings to determine the actual character and depth of the foundations of all bridges and culverts of which this information could not be determined from the plans.

OFFICE ORGANIZATION.

Office force of the entire system, in charge of the Valuation Engineer, varied with the requirements of the work from 4 to 22 men, consisting of draftsmen, stenographers, computers and clerks.

The office work consisted of examining the maps, profiles, bridges, track and building records, and from these investigations, together with information shown in field notes a detailed statement or inventory for each account was prepared. All of the items under each of these accounts were segregated according to:—

(1) corporation,
(2) main line,
(3) branch line,
(4) states,
(5) counties,
(6) corporate towns,
(7) main track and
(8) side track.

After all the property was thus listed on the proper forms used for valuation, adequate unit prices were worked up from examination of recent actual costs and these prices segregated between labor, material, transportation, etc., and were then applied to the inventory.

All information in the way of inventories and prices was checked by all means available, and all computations and complications were also independently checked.

On some of the subsidiary lines the work of computing and compiling the qualities was divided among several groups, each in charge of an office assistant or chief compiler. In that way work pertaining to each of the items of right of way, grading, bridges, trestles and culverts, track, fencing, crossings and signs, buildings and structures, etc., was placed in charge of a separate group.

Interlocking and signal apparatus was handled by a man especially assigned to the work from the signal department, and similarly in the case of telephone and telegraph property.

On the line most recently built the office work was done under supervision of the engineer of maintenance of way who was assigned to valuation work, and he used his regular force for this purpose.

On the Atlantic system an especially organized office force, under the direction of the engineer of maintenance of way, was assigned to this work, and he handled the products of the work of the field parties, and all other information in a manner similar to that following the other subsidiaries.

Land areas and values and the assignment of values to the same were handled under the direct supervision of the engineer of maintenance of way by special parties. Some of these land parties visited the various county seats where they made abstracts of sales and assessments from which information final values applicable to the right of way were determined and applied to same by the office parties.

Aspects of the Financial Problem of the Railways

Excerpts of Paper Delivered Before the Railroad Men's Improvement Society

BY DR. H. PARKER WILLIS, SECRETARY FEDERAL RESERVE BOARD

The most fundamental fact in the present railway situation is, I believe, the demand for new capital. For reasons which are known to all and require no detailed discussion from me, the amount of capital invested in new transportation enterprises during the past few years has been insufficient. The mileage of the country has been increased only from 207,977 miles in 1903 to 249,802 miles in 1913. The railroads of the country, considering the difficulties under which they have had to work, have done well in maintaining their investment in plant, equipment, and facilities generally. It would be wrong, however, to believe that they have kept pace with the advancing development of the country in other directions. What the reason for this relative backwardness is, I shall not attempt to inquire in detail at the present time. Certainly the ten years past have not been an encouraging time for the railroads, nor have they been years during which the investor either was or could be expected to be eager and willing to put his funds into transportation enterprises. Now suddenly a new factor has been added. A struggle of unprecedented violence has broken out in Europe with the result of destroying enormous quantities of fixed and circulating capital. This destruction of capital has affected every department and branch of enterprise, and will continue to do so from now until the close of the struggle in which nearly all of Europe is engaged. Various estimates have been made from more or less trustworthy sources with reference to the actual destruction of wealth in the course of this world conflict. I do not believe that any of these estimates can be even approximately accurate. Yet we can, with entire safety, recognize that very vast losses are being inflicted upon the world by three methods—the actual physical destruction of forms of capital, the withdrawal of productive workers from employment, and the actual loss of these workers and their productive power in

consequence of death on the battlefield or from injuries or disease. Much of this loss of capital is of a kind which cannot be measured in terms of money, and much of it cannot be estimated or accurately stated. What we do know is that when the close of the war shall have been reached, however, it may turn out, there will be a very great demand for capital to be used in the upbuilding of industries and in the restoration of those objects of use and production which have been so widely and so ruthlessly destroyed. The natural effect of this shortage of capital will be an increase in the rate of interest, with corresponding competition among those who wish to use capital for the purpose of carrying on business. This demand for capital will be a demand for long term investment funds, not for money. * * * To restore the lost shipping, to replace railway lines, to rebuild factories and generally to put the world where it was before the opening of the struggle as regards productive facilities, will be the labor of a long period. While this is proceeding, other enterprises throughout the world will have to bear their share of the burden. They cannot, if they would, escape the fact that the new capital they need is urgently desired by others who would be willing to pay for it at high prices. Thus, the railways, which are among the greatest borrowers of capital in every country, must, in the nature of the case, in common with other industries, find themselves hampered and crippled by anything which stands in the way of their obtaining the resources they require. They are confronted by a peculiar problem because of the practice which has arisen in recent years of financing their necessities in no considerable degree on a short term basis. We do not exaggerate, therefore, when we say that the capital problem of the railways was serious before the war, that it had been made particularly serious by the practice of short term borrowing, and that the war itself has now placed the roads in an unprecedented position.

While the situation is thus one which presents difficulties worthy of the attention of the best financiers, in so far as the acquisition of capital is concerned, there is a second factor in the situation that deserves very careful consideration, both from the standpoint of what it will do to influence conditions, and of what it will not do. This is the change that has come about in our banking system. Little more than a year ago Congress passed the Federal Reserve Act. This Act provides for the creation of banks of rediscount whose function it is to make banking resources fluid, and by that means to render capital active in a degree never heretofore possible. I do not exaggerate in the least when I say that this Act holds out the greatest promise to business enterprise that has been offered to it for many years.

If the business community contents itself with simply continuing its present methods of operation, it will derive great advantage from the law. It will find (1) that local banks will be able, by rediscounting the paper of local enterprises, to provide the funds needed by such enterprises in their commercial transactions; (2) that there will be no such wide fluctuations of interest rates either geographically or from season to season as now exist; (3) that there will be no necessity for emergency measures to safeguard the country from the possible results of financial panic or stringency. Credit will be more simply available, cheaper, and more equitably open to all. Not the least of the advantages to the business man will be found in the provisions with respect to bank examinations, since through there, it may be hoped, many operations which have been open to criticism in the past will be clearly detected and corrected before they have had time to impair the vitality of institutions which might otherwise have continued sound and solvent.

But while the Act will be of enormous advantage to the business world, and through it to every productive, agricultural and industrial enterprise, it is not well for any thinker on the subject to mislead himself into the belief that such legislation will do the impossible. The Federal Reserve Act is not a measure which has to do with long term investment of capital, and those who look to it as a direct means of relief for manufacturing enterprises, like those who look to it as a means of providing agricultural resources, must inevitably be disappointed. Their disappointment will be based not upon the lack of results, but upon the fact that these results will differ from, and will be exhibited in a way at variance with that which they had expected. It is worth while for me, therefore, to explain with some care, the relation of the Federal Reserve Act to this question of longer term borrowing. Much has been said of the effect of the Federal Reserve Act in furnishing an elastic currency, and in converting good commercial paper into immediate means of payment through rediscount operations. It was natural that the first attention of the public should be centered upon this subject, since it, above all others, has for many years past seemed to constitute the crux of banking operation. I would not for an instant minimize the importance of what has thus been done; indeed, I regard it as the fundamental purpose of the Act. There is, however, much to be said of the effect of the Federal Reserve Act in other directions. One of these neglected phases of the subject relates to the influence of the new law in bringing about a readjustment of the rates of interest upon paper of varying maturities. The Federal Reserve Act specifically limits the paper which is rediscountable by member banks, as well as that which is purchaseable in the open market, to notes and bills running not over 90 days, except in those cases where the paper is drawn to finance agricultural transactions, when the limit is extended to six months. The Act, however, wisely gave to the banks the power of regulating rates of discount on a different basis for shorter and for longer term paper; and to the Federal Reserve Board the power to approve such varying rates. It, moreover, permitted a variation of rates as between different sections of the country, so that both a time and a geographical variation were sanctioned. This was an important advance as compared with previous plans for the reformation of the banking system. Under the older plans it had been intended to create a rate of discount which would be uniform throughout the country; while such plans usually contemplated the rediscount only of very short term paper. The Federal Reserve Act was more carefully adjusted to conditions in that it recognized that much of the business of the United States is done on a relatively long period of credit; and that the fact that this period of credit is longer in some cases than in other, in no sense means that the paper is not liquid, inasmuch as it is practically certain to be redeemed at maturity, notwithstanding that the maturity is postponed. The effect of the Federal Reserve Act, then, is to establish a series of maturities, some longer and some shorter, and to permit the placing of different rates of discount on these maturities. This is an idea of great importance. It is not a novel idea, because every well managed bank of large capital and great scope of operation, endeavors to apply this policy. But it is of greater importance than ever before for the reason that the Federal reserve banks, owing to their ability to discriminate carefully between different classes of paper, will be able to make effective the discrimination they introduce into the rates applicable to different maturities of commercial paper. Inasmuch as they stand ready to take very short term paper in very large amounts at an unusually low rate of discount, they

tend to emphasize the desirability of making obligations run for as short periods as practicable, inasmuch as the longer an obligation runs, the higher the rate of interest to be paid on it.

In other words, the Federal reserve banks are rendering to the commercial community the useful service of emphasizing the time element as compared with the mere element of safety in commercial paper. They will place a premium upon all short term commercial paper, and they will tend, so far as practicable, to discourage the financing of long term obligations through commercial capital except in those cases where the borrower is able to pay a relatively high rate of interest because of the conditions under which his product moves to market. The theory upon which the whole Act is based, indeed, tends to place stress upon the view that very long term obligations, no matter how safe they may be, should not be financed through the commercial banks at low rates, and that they are not as appropriate a medium for investment of funds as are the much shorter term maturities already referred to.

The principle thus recognized has a most important bearing upon the conditions under which many enterprises are financed. It is true that within recent years railroads and other industrial enterprises have turned in many cases to the banks for the purpose of getting accommodation, and the banks have financed them upon the basis of short term notes, such notes running one, two, three or more years. That these notes have borne relatively high rates of interest has been a natural, not to say inevitable, incident in the situation; and the roads have been obliged to bear the brunt of the resulting expense. In other words, they have placed themselves in the position of long term commercial borrowers at banks. Under the new system they will be no more favorably situated than under the old; indeed, the fact that they are borrowing practically on the basis of long term commercial borrows will be emphasized. The commercial banks will inevitably find themselves more and more inclined to keep their assets invested in paper and obligations which do not exceed the maturities mentioned in the Federal Reserve Act; or if, for purposes of investment they place a part of their funds in long term obligations, they will take this step simply for the sake of convenience. They will be inclined to discourage the carrying of borrowers who are really seeking for additional capital; and they will tend more and more to convert their holdings of such borrowers' paper into short term commercial paper.

The direct inference from what I have said is a thought which has often been suggested within the past year or two in well informed quarters, but which has never been emphasized so positively as today. This is that above all things else it is imperative to turn the funding of railway obligations into long term securities, and to place these securities in the hands of the public. What the railroads seek to obtain through the issue of securities is capital for extending their equipment and mileage, and for generally enlarging their investments in fixed forms. The railroad is not in the position of a commercial borrower; and the obligations which take the form of bonds or three year notes, have no such relation to current services and payment therefor, as is the case with paper issued by commercial firms, corporations or individuals. It has long been a familiar fact that the best rates of interest and the most favorable terms were obtained by giving to railroad securities a reasonably long maturity; and it has been equally obvious that the credit of railroads was best safeguarded and the stability of their funded indebtedness was most strongly assured when the securities were widely distributed, and their bonds held by actual bona fide investors who bought them because they sought a safe means of investment for their funds, and intended to hold them because of the income producing power of the securities. From all standpoints, then, and for all reasons, it is most urgent that the commercial banks of the country should be enabled to relieve themselves of the load of short term obligations representing investments in fixed capital, which they are now carrying. * * * To bring about this change does not imply any reflection on railroad credit; but, on the contrary, must be the outgrowth and most marked success of an effort to strengthen it.

How can the public be induced to take up these securities, thus relieving the banks of the necessity of carrying railroad and similar securities, and to hold them firmly and permanently that they may constitute an indefinite investment in the railroads of the country, and may enable the roads to get the advantage of reasonable rates of interest at the same time that they are given the knowledge that they will not be disturbed by any necessity of refinancing themselves at short intervals? The answer to this question can be furnished by making the securities of railways more attractive and more popular with investors, and consequently by producing a stronger and more continuous demand for them.

* * * * * * * * *

The Federal Reserve Act is essentially a means of economizing the country's gold supply and its credit resources. When fully developed, the Act may be expected to set free a considerable amount of capital which has heretofore been needed to carry on short term operations. That is to say, by reason of the fact that short term operations have been provided for on a smaller basis of outlay than in the past, a considerable amount of capital employed in financing these operations will be set free, and will thereby be enabled to go into the long term or investment field.

They will require a considerable period for their complete development, and when they have been fully applied it will still remain true that the financial problem of the long term investor is essentially dependent upon the demand and supply of capital and in its practical working out upon the question, what he can offer to the public. In the case of the railway this becomes a serious matter. As a result of the legislation, with which we are all familiar, intended to control transportation rates, our railroads have become far more stereotyped in practice than formerly. They do not venture to reduce a rate in the hope of stimulating business because they recognize that once reduced, a rate can only with great difficulty be advanced. The railways, whatever the stabilizing influence affecting the rate of interest may be, will, therefore, always have to meet the question whether they can provide the actual net resources that are necessary to take care of their fixed obligations. Undoubtedly the recent advance granted by the Interstate Commerce Commission will be of some service. But will the railroads be permitted to retain those advances? Will public opinion allow the roads to keep for themselves the fruits of these higher rates? Will organizations of employees regard the rates as only a basis for increased wage demands to be taken from the roads as soon as they can by arbitration or other methods, succeed in absorbing them?

This is not a financial problem, it is a question of popular attitude and education. But the problem is financial in this sense. Up to date the railroads have been too largely dependent upon banking institutions for the financing of their obligations. The time has come when the public must be induced and expected to take over these obligations and to carry them as investments. If they cannot or will not do this, then the financial problem of the railroads is truly a serious one. It is undoubt-

edly a fact that the railways of the country, in order to introduce the technical improvements in their financial situation of which I have spoken must be able to furnish the basis of all long term credit—a safe surplus of revenue over expense, applicable to the payment of interest. This they cannot do unless they are enabled to earn satisfactory revenue from freight and passengers, thereby providing for meeting their obligations, and of giving the holder of such obligations meantime, the confidence that his funds are in safe hands. Something has been done, as I have noted, by the recent 5% rate decision of the Interstate Commerce Commission. This decision, however, is of more importance in what it suggests than in what it accomplishes. The basis for it is manifestly found in the statement that the railroads are recognized as having distinct and ascertainable needs, and are to be authorized to collect sufficient revenue for the service they render to compensate the holders of their securities for the use of the funds intrusted to the carriers themselves. There has been an unmistakable turn in public opinion with regard to this subject. So long as the roads were regarded as possessing unlimited resources, practically indestructible by any kind of legislation or exactions, there was little hope of establishing a business basis for the acquisition of railroad capital. It is only when the railroad is recognized as being a public utility both as regards its claim on the public and as regards it obligations, that a just balance between service and income can be developed. Such a balance it must now be the effort of the country to obtain. How can it accomplish the result? First of all, the dictates of the situation call for the development of a theory of railroad rates which will result in giving to the carriers a return upon all capital legitimately invested by them. Regulation cannot work only in one direction; it must operate to the advantage of the railways as much as to their disadvantage. It is traditionally a poor rule that will work only one way; and in this case, efficient service to the community dictates that the laborer shall be considered worthy of his hire. If railroads cannot tax the public according to their own will, as we all today, I think, agree that they should not, then the public cannot afford to tax the railroads to such an extent as to destroy the capital of those who have legitimately invested. Neither can the railroads be expected to go on extending their facilities and increasing their services to the public unless they are guaranteed at least that minimum rate of living wage which is demanded by laborers in the interest of society. It may be an unpopular saying, but nevertheless a true one, that the wages of capital must be paid quite as regularly and quite as fully as those of labor, if capital is to continue to perform its functions in the community. Those who save and invest capital, will not continue to do so if their savings and investments are so affected as to yield them no return. The great mass of the public appreciates the problem and sympathizes with the difficulties of those enterprises in which they are themselves interested much more strongly than in those which are to them only an abstraction. This is true of the railways. There has undoubtedly been a large advance within recent years in the distribution of both stock and bonds of the carriers among the public at large. But rapid as this progress has been it has not yet been rapid enough to meet the requirements of the case. It has not gone far enough to solve the difficulties of the situation. It has not reached the real root of the difficulty. Too much railroad capital has been derived from the banks and financial institutions, and has been carried by them as part of their investments. Too much railroad capital has been obtained through the sale of shares and bonds under conditions that have not resulted in attracting the real ultimate holder. A few objectionable operations within recent years have done more to frighten and alienate the small holder than a long period of popular education could do to attract him and overcome his prejudice. It is necessary to get the shares and obligations of the railroads into the hands of the mass of the public, and to make them really and in fact proprietors of the transportation lines. This measure is called for urgently from the financial standpoint for the reasons which I have thus set forth. It is, however, called for much more urgently from the social standpoint. The carriers are public utilities. And this character is not one-sided but must be considered from every aspect. The roads should be public in the sense that they appeal to and depend upon public support as well as in the sense that they must render public service and must meet the requirements of the community for accommodation. When in this sense the railroads have been popularized with the community, a two-fold benefit will result. The banks and investment institutions of the country will be relieved of the necessity of carrying long term investments when they should be devoting their funds entirely to the development of commerce and business, while on the other hand the people who are holders of the securities, will recognize the claims of those who look to the railroads for earnings, as well as of those who look to them for accommodation.

When this result shall have been attained, and in proportion as it shall have been attained, the so-called rate problem will have disappeared. The public will no longer look upon the railway as an incubus, and will begin to regard it as a business partner. It will no longer feel that every dollar paid into a railroad treasury is a dollar deducted from the community's well being, but it will recognize the same mutuality of benefit in dealing with the carrier as is recognized in local communities where men deal with others because they expect those others to deal with them in return.

Things We Run Against

Excerpts from the Field Notes of an Early Government Survey—Interesting Incidents of Years Ago

By H. H. Edgerton

"It has grown wonderous cold. Abraham has been missing for three days."

(Two days later.)

"Found Abraham sitting against a creek bank. The wolves had eaten away his face and hands. His ring was still on the bone of his finger. I have taken it to send to the Surveyor General's office that his people may get it. We could not dig through the frozen ground, and there were no stones to cover his body, so we left him sitting there." * * *

At the close of a long meander of the bank of the Red Cedar River in Iowa, A. Z. Hazen, United States Deputy Surveyor, writing in his field book under date of June 20, 1845, makes the announcement:

"Today hung my socks up. The climate is good for that." * * *

The same Surveyor, under date of October 31, 1846, when he closed his section lines on what is now the city of Waterloo, Iowa (a town of 25,000), makes the following comment:

"2nd rate prairie. Timber 2nd rate, lots of bird's eye maple; a beautiful place, but too far from the Mississippi River for anybody to settle."

* * *

While it was "socks up" for Hazen it was mits up for another engineer, not figuratively, but actually. He

was a locating engineer on the Canadian Northern Railroad in Manitoba in 1902. He was caught out in a blizzard and hung his red mittens up in a lone tree to guide those who should look for him, and there they found him —dead.

These may be dull times, but there are still lots of chances for bright minds who know the business of railway engineering.

From the deed record of Black Hawk County, Iowa:

"Also so much of sections 25 & 36 as may be overflowed by raising a dam on said Big Creek near the house occupied by George Cook on the 1st day of April, A. D. 1856, to the heighth of 13 feet."

To which someone has penciled on the margin:

"Wanted—A railroad engineer to stake out the boundaries of this tract and show where the —— —— railway right-of-way is across it."

* * *

The deed records of Hennepin County, Minnesota, contain the following ridiculous description of a piece of railroad right-of-way, and the job is still open for some clairvoyant engineer to find out what his co-worker meant when he wrote it:

"Thence in a 10 degree curve S. 25 W., 100 feet; thence S. 30 W. 100 feet; thence S. 45 W., 299 feet to a hub; thence turning and running to the point of beginning."

Which way and how much he turned and how far he ran after he got turned "the deponant sayeth not."

* * *

From a resident engineer's "Miscellaneous Notes," Memphis & Charleston Railroad about 1850:

"Sold James and John to a steamboat captain—$500 Spanish silver and bills of exchange—neither one of them could keep tally."

James and John were probably negro lads he tried to use as Chainmen.

* * *

What is now Defiance and Paulding counties in Ohio was surveyed by Captain Riley in 1819. Captain Riley had been a captive among the Moors in Morocco for 20 years. When he escaped he came to America, wrote "Riley's Narrative," and was appointed a U. S. Deputy Surveyor for Ohio. During his captivity he undoubtedly suffered many hardships, yet one of his field books contains the following comment:

"I would rather take the horrors of the Saharah than the mosquitoes of this country."

* * *

The Miami canal in Ohio was surveyed and constructed some time about 1830. At the summit of the Auglaize River there is a 22-mile stretch, "level," that runs straight north and south. When the water was first let into it, it over-ran at the south end. At that day and age the "water level" was supposed to tell the tale and be the infallible proof that the engineer's work was right or wrong. The levels were re-run. In closing the last notes Miller Arrowsmith makes the following comment:

"These levels are right to a skeeter's hair whether the water runs over or not."

And he was right. It was the wind that made the water back up and run over. They know now that a long, straight level stretch must have offsets, windbreaks, and equalizers. The writer used this same levelling instrument in 1904, and found it capable of working to a "skeeter's hair" if he knew how to handle it, but how many levellers of the present day would have such confidence in their work if they saw the water spilling over and did not know it was the wind that caused it?

* * *

There is probably not a month in the year that an engineer on maintenance does not have to deal with a section corner, provided he is working west of the Alleghaney Mountains. The practical beginning of our wonderful system of sectional land surveys was made by General Coffey in Alabama in 1809. The original field books of these surveys among their great masses of purely mathematical tabulations, contain also some intensely interesting notes pertaining solely to the human side of the life of a surveyor, and set forth rather tersely some remarkable experiences. It seems that the government after passing the necessary legislative act to start the work, was unable to pay for it in cash, so limited in funds was the exchequer of the young republic. The work was given to General Coffey, an officer of the Continental Army, deserving of something at the hands of his country. For want of funds he was unable to start until an amendment was made to the bill, whereby he was to be paid in land, probably one section for each township he surveyed. With this as a prospective credit he was able to borrow $2,500 in Philadelphia, and purchased an outfit of two teams and wagons, provisions and surveying instruments, and with his four sons and two negro slaves as assistants, started on the long journey, by boat down the Delaware, and to Chesapeake Bay, and then up the James River. Then by team over the Alleghaney Mountains, and by boat and raft down the Holston and Tennessee rivers. The trip required one year, and the getting ready two years. On an island near the Mussel Shoals of the Tennessee River they cleared off some land and planted crops to sustain them. Three years after the awarding of the work the notes began.

"In the cemetery of the settlement of Twickenham (Huntsville, Alabama), I have erected a large stone shaft and marked it 'Range 1 East, Range 1 West, Town 1 South, Town 1 North'—the beginning of the surveys of the United States."

As the months to years drift on and on the notes tell the tales of want and privation.

"We are ale all very threadbare and there are no fabrics to be had."

"If our farm was only stocked with poultry and swine it would add much more to our subsistence."

"Our chains are getting much worn at the link connections and will not last another season."

"Our compasses need the attention of an artisan who understands that business. They are getting very unreliable."

(The iron ore deposits of Alabama were doing it.)

"We need so many things I fear I shall have to send someone back to Richmond or Baltimore on foot and return with another team. The trip will take a year."

He did send one of his sons and when he returned he brought a wife with him, and the land they received made the basis of a great family fortune. It is known everywhere in Alabama to this day as "Coffey land," the same as we speak of school land in other places.

The Careful Guarding of a Big Bridge

Description of the Unusual Precautions Now Being Taken to Guard One of the World's Greatest Railway Bridges

By W. McD. Tait

One of the most gigantic engineering works in Canada is the large viaduct carrying steel across the Belly River, just west of the city of Lethbridge, on the Crow's Nest branch of the Canadian Pacific Railway in Alberta. The bridge is over a mile in length, and has a maximum height of 314 feet above the bed of the river. It is the longest and highest bridge in the world.

The discovery a short time ago of some 23 kegs of

Letheridge Viaduct, Canadian Pacific. An Attempt to Blow Up This Was Frustrated.

blasting powder under the great viaduct seems to indicate an attempt to blow up the structure, probably by enemies of the country, with the object of stopping traffic on the Crow's Nest branch of the railway. This would seriously interfere with the transportation of supplies to the east and would, of course, deter the mobilization of the volunteers from British Columbia and Southern Alberta.

The powder was found in a deserted shack, following the report from a coal company in the vicinity that a quantity had been stolen from their magazine. When the mounted police visited the river bottom beneath the bridge, where the shack was situated, nearly 700 pounds of the highly explosive material was found ready to light. The police cached themselves and soon discovered a German miner wading the river toward the powder. He was arrested and will be charged with attempting to blow up the bridge.

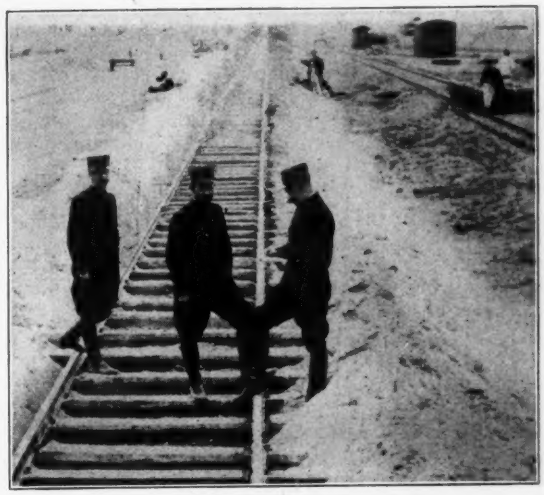
A watchman has always been maintained to guard against accident. After each train passed over the bridge this officer took his mile walk to the other end and waited for the next train, when he returned on his beat. There has not been an accident on the viaduct since it was turned over to the operating department of the railway company. A heavy guard now watches the bridge, both day and night, and it will be quite impossible for anyone to approach the structure without being seen. The bridge required 645 cars of structural steel in the construction, and altogether 1,000 cars of material was used. The structure is considered one of the wonders of structural architecture.

The Santa Fe will expend about $75,000 for constructing 4 miles of track at Corona, Cal.

Interesting War Zone Photographs

Showing Railway Reconstruction Being Done by Both Conflicting Forces.

JANET M. CUMMINGS



French Engineers Rebuilding Railway in Flanders Destroyed by Germans.

German Railway Construction Corps Rebuilding Track in a French Town Destroyed by Allies.

The Modern 150 Ton Track Scale

Showing Necessity of Substantial Foundations for the Modern 150-Ton Track Scale with Specifications of Scale Proper.

Many weighing installations have failed to give satisfaction to its owner and designer, because the requirement was not thoroughly analyzed. It is necessary to understand the construction of scale and the value of soils to support the structure. The scale manufacturer does not object to furnish the data to enable correct proportioning of piers and walls, which must be obtained from the distribution of load upon the lever system.

In a former article the reactions of various loads were shown in bearings of platform, it is now the object to go deeper into details to secure better foundations.

The construction of a track scale is best described by assuming a cut cross-wise of track from rail down to bottom of pit, as seen by illustrations Fig. 5 and Fig. 7. Fig. 5 shows two piers K and one pier L, of which there are twelve in a 50 ft. 4 section scale. Upon K are mounted the main levers M resting on points a, receiving the load at b from rails and transmitting it to a higher series of levers O and I at points C. It is plain that the load from rails passes through eye-beams to b and divides here to a and c in a ratio as set forth by distances $\frac{a\ c}{a\ b}=4$. The loaded gondola car of 160,000 lb. will then deliver $\frac{160{,}000}{4}=40{,}000$ lb. from all levers M to the next series of levers contained in this track scale. If now a second cut is made near center parallel rails, the 4 piers L are found to be about 17 ft. apart, each supporting one of the longitudinal levers O and I. Here again a indicates supporting point, b the receiving point and c

the transmitting point. Levers O are called the outer levers, I the inner levers, meeting near the center at D, causing here an opposite motion, as indicated by arrow, which is reacted in foundation by beam N, Figs. 6 and 7.

In the January issue of *Railway Engineering and Maintenance of Way*, page 59, Figs. 1 and 2, a 50 ton gondola car, Fig. 3 similar car coupled and Fig 4 a 195 ton locomotive. To these loads apply the weights given here in Fig. 6 as they advance into the second series of levers at points b there is in line Fig. 1, 7,620.5 lbs. outer lever, 12,379.5 lbs. inner lever, 12,379.5 lbs. inner lever, 7,620.5 lbs. outer lever. Total, 40,000 lbs.

The other weights stated with Figs. 2, 3 and 4 are the equivalents for car moving, in train order and locomotive when added from left to right give also a sum equal to the total pull at b, which multiplied by 4 (ratio of main levers) indicates the load upon two rails, generated by gondola cars and locomotive.

These outer and inner levers have a ratio $\dfrac{a\ c}{a\ b} = 10$ fixed by distances a c to a b, reducing the already reduced load at points b from 40,000 lbs. to 4,000 lbs. at D. It is interesting to note that the inner levers receive from the outer levers at c 1/10 the pressure of b and transmit this amount unaffected over a in O and I to D, where the accumulation of inner levers unites and gives from Fig. 4, 9,762.5 lbs.; Fig. 3, 5,000 lbs.; Fig. 2, 4,000 lbs.; Fig. 1, 4,000 lbs.

Taking again Fig. 1 for demonstration: 4,000 lbs. is the quotient obtained by division of total load by the product of ratios in levers over which the load has passed.

$$\frac{160{,}000}{4\times 10} \text{ or Fig. } 4 - \frac{390{,}500}{4\times 10} = 9{,}762.5.$$

Proceeding, note that the locomotive agitates the lever system at this point with a reduced force, in fact:

$$\begin{array}{rl} 390{,}500 & \text{upon rail} \\ -\ 9{,}762.5 & \text{at D} \\ \hline \end{array}$$

indicates 380,737.5 lbs. as the difference absorbed by foundation upon 8 piers K and 4 piers L. Since the main levers have a ratio of 4, three-fourths of 390,500 lbs., or 292,875 lbs., is simply divided upon 8 piers K, the various loadings Figs. 1 to 4 exert uneven reactions, therefore, all piers should be proportioned to suit the greatest amounts. This will make the end piers stronger than necessary and pays a tribute towards allowance for impact at a desired point.

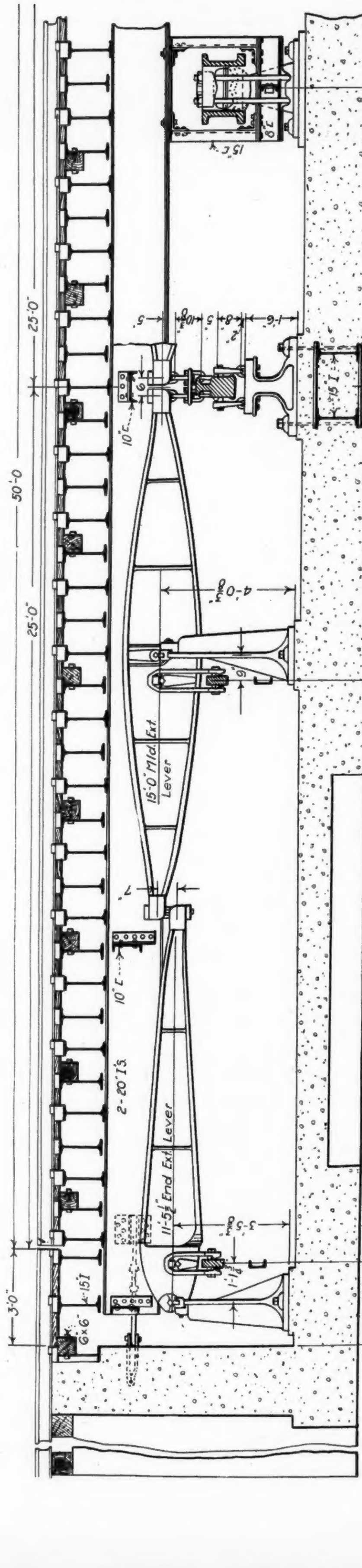
Adding the reactions on 4 piers L, which pass through points a: Pier 1, 12,874.5 lbs.; pier 2, 46,579.9 lbs.; pier 3, 33,552.4 lbs.; pier 4, 14,380.7 lbs., total, 107,387.5 lbs., entire load on 4 piers L minus reaction D, which as seen is 1/40 of load and it is 380,737.5 lbs. 39 times greater than D.

These quantities further arranged:

$$\begin{array}{rl} 107{,}387.5 & \text{reactions L} \\ -\ 9{,}762.5 & \text{at D} \\ \hline 97{,}625.0 & \\ +\ 292{,}875.0 & \text{reactions K} \\ \hline 390{,}500.0 & \text{total weight of locomotive} \\ -\ 380{,}737.5 & \text{total vertical downward absorption} \end{array}$$

Gives 9,762.5 total vertical upward force D.

To understand the continuation of the lever system, remember that 8 main levers M cross the rails, the 2 inner and 2 outer levers sway in center line between and below rails, meeting in cross center line at D, whence they deliver the force to the single center lever C. This lever is



Longitudinal Cross Section of Scale Pit Showing Lever Arms in Place.

suspended at right angle below inner levers by the draft rod from lever B and inner levers I by suitable hangers and anchored to foundation at N, Fig. 7.

It is $\frac{a\,c}{a\,b} = 5$ and c b 10 ft.

$$a\,b = \frac{10\times12}{5+1} = 20'', \quad a\,c = 20\times5 = 100''$$

Assuming a minimum load as gondola car at 160,000 lbs., a mean load of 200,000 lbs. and a maximum load of 390,500 lbs. upon rails, the force at D for the locomotive will be as seen before 9,762.5 lbs. at point b and

$$\frac{9{,}762.5}{5} = 1{,}952.5 \text{ at c.}$$

Adding these two forces gives the reaction of 11,716 lbs. at N. To resist this considerable force, speaking figuratively, a metal ingot of not less than six tons should be buried here and the anchor rod attached to same, or mechanically two channels reaching from pier 2 to 3, Fig. 6, may be imbedded in floor of foundation, the reactions on piers L are greater under load than six tons and will, therefore, retain the smaller force. Should the span be more than 17 ft. it may be more economical to set these channels N parallel center lever and imbed ends under the surrounding wall and floor of pit in this case the total weight of channels, floor and vertical walls should exceed six tons.

The total reduction from rails to draft rod is $4\times10\times5=200$ and beam lever B increases this ratio to 200×4 to 800, setting up a pull from locomotive to

$$\frac{390{,}500}{800} = 488 \text{ lbs. in beam rod.}$$

It is in lever B

$\frac{a\,c}{a\,b} = 4$ and c b 31 inches.

$$a\,b = \frac{31}{(4-1)} = 10\tfrac{1}{3}'', \quad a\,c = 10\tfrac{1}{3}''\times4 = 41\tfrac{1}{3}''.$$

Finally, lever W, which is also called beam equipped with graduated capacity engraved upon a brass plate, has a ration of $17\frac{1}{2}$ from point b to tip (end). All ratios 4, 10, 5, 4, $17\frac{1}{2}$ multiplied give 14,000, this product is also equal to the load divided by counter weight $\frac{390{,}500}{27.89} =$ 1,400 approximate to one decimal point. The total reduction may also be established from measures directly as follows:

Assume: l to be the distance from stationary pivot a to transmitting pivot c, f the distance from a to b in any lever and particularly l^1 and a^1 referring to main levers M, l^2 and a^2 corresponding distances for inner and outer lever, l^3 and a^3 to those of center lever, etc., then we have

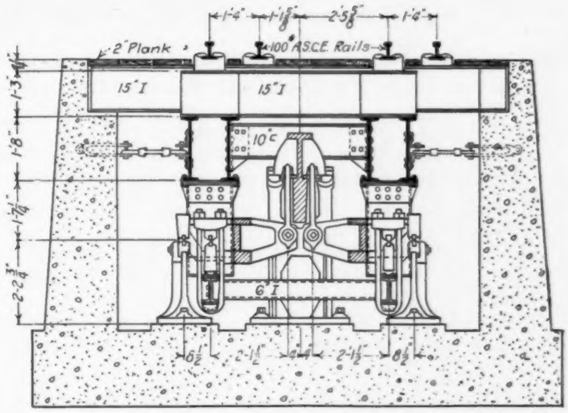
$$M = \frac{l^1\, l^2\, l^3\, l^4\, l^5}{f^1\, f^2\, f^3\, f^4\, f^5}$$

Substituting figures:

$$M = \frac{34 \quad 137.5 \quad 100 \quad 41\tfrac{1}{3} \quad 70}{8.5 \quad 13.75 \quad 20 \quad 10\tfrac{1}{3} \quad 4} = 14{,}000.$$

This method holds good on any scale regardless of class or kind of levers selected in design.

With Fig. 6, beginning at D minimum pull, mean and maximum are giving up to draft rod, whence the maximum is only given, this plus the dead load of structure



Transverse Section, Scale Pit, Showing Detail of Lever Suspension.

should be used in designing of levers as well as foundation.

The same thickness should be apportioned to end walls because here the impact occurs from terra firma to the artificial structure and vice versa, as the traffic may be. A reduction to 18" walls is permitted in vault under weigh-house, where the beam W is arranged. To determine the floor of foundation it is important to know the character of soil; if rock, the piers may be built directly upon it; all other soils must be examined by proper experts and the thickness of floor under piers dimensioned accordingly. Scale manufacturers submit foundation plans before the scale is purchased and ground broken to permit proper development, yet unscrupulous buyers and contractors begin to trim size of walls and prefer that scale which takes the least material. The results are invariably in accord with the judgment displayed, a heavier floor or mat under foundation will quickly absorb all vibrations and keep mechanism in alignment from one end to the other, whereas the lighter foundation begins soon to chatter, sink, under the varying loads, more in one spot than in the other, and thereby gives incorrect weight long before the owner is aware of the losses.

A distorted foundation may be temporarily leveled up, but all such mediations never redeem the original error. It is a fact that all weak constructions are found out, the heavier ones pass as correct and not hurt the reputation of the designer nor the firm standing back of the machine.

In climates as found in the United States south of Chicago and north of Oklahoma the depth of foundation from underside of mat to underside to rail should be never less than eight feet, should be increased in Michigan and Canada and reduced in tropical countries if the scale mechanism does not take up this depth.

Having brought the heretofore not considered distribution of weight on the foundation to attention, another definition of a track scale appears, namely: the foundation is a structure which absorbs by far the greater weight than that which is utilized to ascertain the value of the cargo in pounds. When 390,500 lbs. are pressing upon rails the last lever W operates with 488[x] lbs. against 27.89 lbs. The sum of all reactions below rails and office floor

is	390,500.000	lbs.
minus	1,952.500	lbs., the amount transmitted by the draft rod to office floor,
namely:	38,547.500	lbs.
Finally lever B adds	1,464.375	lbs. to pressure on floor
and pull of	488.125	lbs. at beam rod
checks	390,500.000	lbs. as the load and its distribution anywhere on foundation.

The Snoqualmie Tunnel, C. M. & St. P.

Description of the Construction and Operation of the Latest Continental Divide Tunnel. The largest on the Milwaukee System

The recently completed Snoqualmie Tunnel of the C. M. & St. P. Ry., boring through the summit of the Cascade Range sixty miles east of Seattle, was officially opened to traffic on January 24, 1915.

The tunnel of a modified horseshoe section is 16 feet wide and has a height of 24 feet from crown of arch to the rock floor. The sidewalls, 16 feet high, carrying a semicircular arch of 8 feet radius, are on an average 12 inches thick except at the bottom, where the lower 6 feet have a batter of 4 inches in 6 feet. The electric cables and telegraph wires are carried in two 3-inch fiber conduits embedded in the concrete of sidewall. At intervals of 300 feet on this side of the tunnel safety niches 24 inches deep, 6 feet wide and 6 feet 6 inches high are built into the sidewall. These refuge chambers serve as inspection chambers for conduits.

The track is laid on rock ballast with a minimum of 12 inches under ties, thus making the clearance 21 feet 6 inches from base of rail to crown of arch. To take care of the seepage water concrete gutters 12 inches wide were constructed on each side of tunnel, close to sidewalls. At intervals of from 150 to 300 feet diagonal baffle walls of concrete are built on the floor of tunnel to conduct the seepage water to the gutters. At the points where water passes through the gutter curb wall it enters a 4-inch pipe which discharges into the gutter some distance beyond, thus avoiding direct connection of gutter with floor.

The track is of 90-lb. A. R. A. rails laid on creosoted oak ties with 60-lb. guard rails the full length of tunnel.

DESCRIPTION OF SITE AND CONDITIONS PREVAILING.

Although the original plans of the Coast Extension line through the Cascades called for a summit tunnel, it was found expedient at the time of construction to build it over the summit as an open high line through Snoqualmie Pass. The grades and curvatures of the high line were necessarily excessive, there being 4.7 miles of 2.2 per cent ascending grade from Keechelus to Laconia and 4.4 miles of 2.75 per cent descending grade from Laconia to Rockdale, having in all 14.48 degrees of curvature, making it necessary to use a Mallet helper on all westbound through passengers and tonnage freights and one Mallet helper on eastbound through passengers, while two were required on eastbound tonnage freights. In addition to the pusher service, the winter operating conditions presented a serious problem, as the snowfall at the summit has exceeded fifty feet in a single season and during the winter of 1912-13 transcontinental traffic was closed for ten days, due to snowslides on the high line.

Shortly after the line was opened to traffic (1908) surveys were made for the summit tunnel and a little work was done at the west end prior to April, 1912. In June of that year the actual driving was started, but was restricted to a limited monthly expenditure, and it was not until the disastrous winter of 1912-13 that work was pushed to the limit, and from that time until the first train passed through men worked ceaselessly.

The tunnel line leaves the main line at Rockdale, the west portal of the 11,902-foot tunnel, being 658 feet east of the junction point, and connects with it at Keechelus, on the east slope, some two miles east of the east portal. The new line reduces the distance between stations mentioned 3.7 miles, eliminates 433.5 feet of rise and fall, 1,239 degrees of curvature, and all pusher service between Rockdale and Keechelus and practically all of the snow trouble of the Cascade Summit.

With the exception of two short curves, a 6-degree at the east and a 3-degree at the west, the tunnel line is tangent and has light grades, there being a .1 per cent ascending grade from the east portal to a point 2,000 feet inward, from where there is a .4 per cent descending grade to the west portal, the high point being 2,561.9 feet above the sea level.

The ground rises abruptly from the west portal, and at a point 2,000 feet east the top of the mountain is 1,600 feet above the tunnel section; from the top it slopes gradually to the east. There are several small snow-fed lakes on the east slope, which were undoubtedly the source of the several streams of water encountered during the driving of the tunnel.

CONSTRUCTION.

The tunnel section for the greater part of the way passed through bodies of massive black slate that were

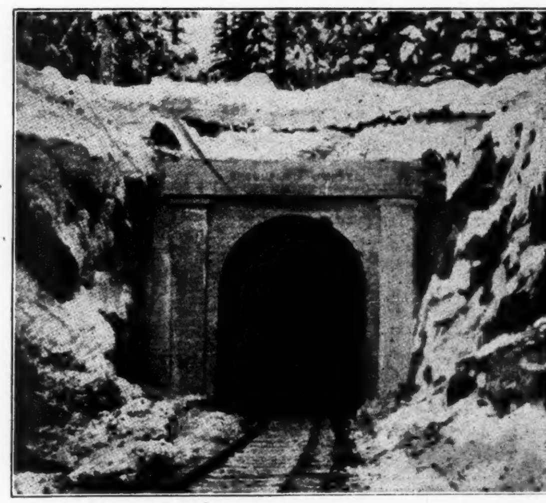


Fig. 1. Portal of Snoqualmie Tunnel, C., M. & St. P.

intercepted by stratas of gray quartzite, blue conglomerate and an andesite dike, all of which dipped slightly to the east. These formations are considered good tunnel rock, and, as expected, varied greatly in hardness. The andesite dike in places required thirty hours' continuous drilling to get a heading round of 9-foot holes, while in places the black slate was drilled in two and three hours. The rock was all of good quality; did not weather or swell when exposed to the air, but the strata were badly fractured and the seams filled with talc, making it necessary to line the entire tunnel with concrete to prevent any possibility of a roof fall.

After taking into consideration the many conditions that tend to govern an undertaking of that size, it was decided to excavate that portion of the tunnel that was to be driven from the west portal by the European or bottom heading method, which is, briefly, as follows:

An advance heading 8 feet high by 13 feet wide was driven at sub-grade and to one side of the tunnel section, the work being carried on continuously by three shifts of men who worked six hours and laid off twelve. Each shift consisted of four drill runners, four helpers, ten muckers who worked six hours, and a shift boss, nipper and heading skinner who worked twelve hours. These men were paid on an hourly rate, in addition to which was a bonus of an hour a foot for all progress over ten

feet a day, the work being measured every ten days. When the rock was good bonuses were often made, and the average progress for 6,971 feet of bottom heading was 9.5 lineal feet per day with a maximum of 25 lineal feet in a single day.

The work in the heading was divided into several operations, all being preparations for blasting, the average time between shots being sixteen hours, but under ordinary conditions a shot was fired about every twelve hours. Two and one-half to three hours were spent in breaking down the roof in the part just blasted and in pulling back the broken rock from the face of the heading to allow the drilling to proceed. Seven hours for setting up the drill crossbar and drilling the 14 to 30 9-foot holes required to break the rock. One hour clearing the drills, loading and shooting. One hour waiting for the heading to clear of gases. While there were many exceptions to the above, it was the general program followed day after day until the east and west headings met.

The next step in excavation was the widening of the heading to full width of the tunnel section, after which the stope timbers set five feet center to center were placed. These timber sets were composed of 12x12 posts and 12x14 caps, with stringers running parallel to the tunnel, upon which were laid flooring that could be lifted, allowing the bench muck to fall into cars standing on tracks below the timbering.

After the stoping timbers were in place, openings about 150 feet apart were driven upward to the full tunnel section, and from these openings the upper bench faces were drilled and shot down on the stoping timbers, from where the material was dropped into cars and hauled out on the dump. The cars were handled by horses on a double track narrow gauge as far as the bench; at this point they were made up in trains hauled by gasoline locomotives. Steel rocker dump cars of 1 yd. capacity were used for work at the tunnel face, the 1½ yd. cars used in widening the heading being too high for hand shoveling.

The average progress on the bench at the west end was 7.7 feet per day, the progress on this work varying greatly, depending on the labor conditions, which were good during the winter and decidedly bad during the harvest season.

In order to ventilate the tunnel workings a 24-inch exhaust pipe was carried to the end of completed bench and a 10-inch blower pipe (of canvas to within 100 feet of heading face) was run to the heading. Booster fans were put on the line at intervals as the length increased.

If the rock was in good condition, the stoping timbers were taken down and moved ahead after the bench material was out. If it required timbering, they were sometimes left in place and an "A" frame placed above to hold the roof until the concreting reached that point, after which both "A" frame and stope timbers were removed.

At the east end of the tunnel there is a long approach cut, and at the time the driving from the east portal was started it was not complete, so it was necessary to start the work from that end, as a top center heading, which was widened to full arch section and either timbered or concreted before the lower bench was taken out. The organization and method of handling top heading was practically the same as that described above for the west end. The average progress was ten feet per day.

After the heading was widened to full arch section, shafts were sunk to subgrade at intervals of 1,000 feet, from which drifts were run both ways and the bench removed by stoping as at the west end, the average daily bench progress having been 10.3 feet.

TUNNEL LINING.

As before mentioned, the entire tunnel was lined with concrete before it was opened to traffic, and this feature not only saved considerable on construction cost, but made the completed portion safer for the men, and the short time that elapsed between the completion of the excavation and the placing of the lining allowed the minimum amount of temporary timbering to be used. The sidewalls up to springing line arches were concreted in 50 to 100 feet sections and the arched roof in 12-foot sections.

Concrete mixing plants were constructed outside the tunnel at each portal, planned so that the material traveled downward as much as possible from the gravel cars to the ½-yard steel dump, concrete cars that carried it into the tunnel.

The concrete gravel was obtained from Ragnar Pit, about seventeen miles below the tunnel, where it was sluiced directly into bottom dump Hart convertible cars, which were hauled to the tunnel material tracks by the way freights. These cars were handled on the supply tracks by cables, in this way avoiding the costly item of work train service.

To avoid interfering with the muck trains at sub-grade, a high line concrete track was built at the springing line 16 feet above sub-grade by placing 8x12 timbers, 5-foot centers, with the ends projecting into the concrete side walls and upon which the concrete tracks were laid. This high line concrete track served a triple purpose—allowed two-thirds of the concrete to be placed by dumping directly into wall forms, kept concreting cars and materials in the clear of the driving operations, and acted as a support for the movable arch forms. The concrete for arch roof was shoveled into place.

While the lining work may appear a small item, it must be realized that there were placed over 75,000 cubic yards of concrete, requiring that many yards of gravel and 500,000 sacks of cement in addition to all the form lumber, hardware, etc.

CAMPS.

Camps at the tunnel portals were modern and considered far above the standard construction camp, the men being furnished with bunk houses having toilets, hot and cold water and shower baths. The dining halls were large and kept in sanitary condition, and the food, for which the men paid 25 cents per meal, was of good quality and the men were always satisfied. The St. Marie's Hospital Association maintained a doctor and an emergency hospital at each end, where first aid was furnished to those seriously injured and attention given to all minor ailments and injuries.

J. I. Horrocks, engineer and superintendent, Snoqualmie Tunnel, was the man on the job to whom fell the direct responsibility of handling the Milwaukee's longest tunnel and turning it over to the Operating Department complete.

OPERATION.

From Hyak, the station on the east approach, to Rockdale on the west, trains are run through on the "Staff Block" System. It is an interlocking device that provides the engineer and conductor on a west-bound train, for example, with two metal slugs, each representing half a unit, to enter the tunnel. Both these men must have in their possession one of these metal pieces. They are released by the agent from an oblong case, which in appearance looks like a time clock. This instrument will then not issue another clearance until the metal pieces handed the conductor and engineer are put together and inserted in an instrument of the same type at the Rockdale end. As soon as this is done it automatically flashes a clearance to the Hyak end that the train which entered has passed through. Everything on wheels going into the tunnel, even hand cars, must have this clearance to get

in or out. The "Staff Block" is the most highly perfected "Safety First" system known in train operation.

COST AND ECONOMIES EFFECTED.

The cost of the completed tunnel is approximately two million dollars. While it is true that railroad construction running into nearly seven figures per mile represents a fabulous cost, it is equally true that the business acumen of the management of the "Milwaukee" Road would not permit any such expenditure unless it was a proven economical advantage, and eliminator of delays and a reducer of both mileage and time. All of these traffic benefits are part and parcel of the Snoqualmie Tunnel. They are, in fact, the only reasons for its existence. Roughly, the expense of maintaining the "High Line" over the pass, before the days of the tunnel, called for an outlay of nearly ninety thousand dollars yearly for helper engine service to assist in moving trains over the stiff grades encountered in the climb to the summit. The line has been shortened three and seven-tenths miles. Calculating this saving for sixteen trains (ten freight and six passenger) at one dollar per mile for three hundred and sixty-five days, piles up a yearly operating expense of twenty-one thousand six hundred and eight dollars.

To have continued to use the "High Line" would have necessitated the construction of sixty-six hundred feet of snow sheds built of 12 by 18 timber stout enough to stand under an avalanche of snow and rock that slides down the mountain sides at most unexpected times. The estimated cost of a structure of this kind is fifty dollars a foot. A bit of mental arithmetic shows that a snow shed of the length required would mean an outlay of three hundred and thirty thousand dollars. On top of this would come a yearly expenditure of nineteen thousand eight hundred dollars for renewals and repairs that would have to be made to keep it in first-class condition. The cost of operating the "High Line," therefore, is equivalent to what three million three hundred thousand dollars would earn at five per cent. The tunnel cost approximately two million dollars. This at once conveys an idea of its economical advantage, and also the significance of the prodigious sums that the road must spend today to conserve its dollar tomorrow.

PERSONNEL.

The tunnel was designed by the engineering department of the C. M. & St. P. Ry., Mr. C. F. Loweth, chief engineer, and the entire construction done by company forces in charge of Mr. J. I. Horrocks, engineer and superintendent acting under Mr. E. O. Reeder, assistant chief engineer, Lines west of Missouri River.

The article presented here is an abstracted composite of a general article on the tunnel and a detailed description of same by M. A. G. Holt, assistant chief engineer, lines East of Missouri River, appearing in the February issue of the *Milwaukee Railway System Employes' Magazine.*

The city of Springfield, Mo., contemplates the construction of a concrete viaduct to span the tracks of the St. Louis & San Francisco Ry. and the Missouri Pacific Ry. and the Springfield Traction Co.

And now doctors will be crying for cement. The latest use of it described in the daily papers is as a ready-made dressing for broken bones. A laborer in Columbus, Ohio, had his leg broken by a blow from a dump-bucket loaded with concrete. The concrete fell out on the broken limb, and set before he was moved. When the doctors went to set the broken bone, they found it incased in a very effective cast.—*Concrete-Cement Age.*

The Railroad Commission of Wisconsin has ordered the C. M. & St. P. Ry. to build a reinforced concrete bridge over its Sauk Road crossing at Mendota Beach near Madison, Wis. The bridge to be completed in nine months at an estimated cost of $15,000.

Slaked or hydrated lime to the extent of 10 to 25 per cent added to cement mortar or concrete will render more nearly waterproof the surfaces of flat concrete roofs and interiors of water tanks but unless the best of inspection is provided to see that the proper quantity and quality of lime is used the results may be far from satisfactory.

BIG CANAL PROJECT COMPLETED.

Work was completed recently on the construction of the supply canal of the Ft. Lyon system. The canal will carry the flood waters of the Arkansas river to Horse creek and Adobe creek reservoirs 15 miles northwest of Las Animas. In July, 1911, work was commenced and for three years and eight months the big dredge engaged to do the work has been busy night and day. Ben F. Powell, chief engineer, Carl W. Burke, superintendent of the canal, and Frank Kreybill, secretary of the company, were present when operations ceased. These three men were also present when the first shovel of dirt was emptied and they have been continuously on the job ever since.

The canal is 43 miles in length, 63 feet wide on the bottom, 12 feet deep, and its carrying capacity is 3,000 cubic feet of water per second. The headgate is near Manzanola and the canal carries the flood waters of the Arkansas river to Adobe creek reservoir, which has a capacity of 91,750 acre feet. Carrying its full capacity the canal will fill these reservoirs in 25 days. The entire cost of digging the canal totals $875,000. The dredge cost $28,000.

THE STEHLING CONCRETE MIXER.

On nearly all contracts today a certain amount of concrete work is involved, and a concrete mixer has become a necessary part of every contractor's equipment. For most jobs the medium-sized mixer on account of its lower price and its portability, has become popular with contractors.

The Stehling concrete mixer is a machine of this type. It is a batch mixer with a cylindrical shaped drum, having a capacity of 5½ cubic feet of dry material per batch. The mixer is mounted on a channel iron frame on steel wheels 20 and 24 inches in diameter. The frame is 7 feet 6 inches long and 3 feet 6 inches wide.

The drum is made entirely of steel with ends 3/16-inch thick and shell ⅛-inch thick. The materials in the drum are mixed by the turning action supplemented by both blades and buckets riveted to the sides of the drum. The drum is charged by means of a batch hopper of No. 12 gauge boiler steel, holding an entire batch. The mixed concrete is discharged by means of a hinged chute, which assists in the mixing action when in mixing position.

The drum is driven by a chain drive provided with an idler to take up the slack of the chain. Power is supplied by a 3½ horse-power gasoline engine, provided with a clutch of the expanding ring type. The engine, bearings, shaft and clutch are inclosed in steel housing, protecting them from the weather and from dust and grit.

The mixer has a capacity of from 50 to 60 cubic yards per day. It weighs only 2,000 pounds complete and can consequently be easily moved from job to job and to different places on the same job. The mixer is manufactured by the Charles H. Stehling Company, Milwaukee, Wis.

CONCRETE  DEPARTMENT

Possibilities of Concrete

The possibilities of concrete as a medium of æsthetic expression in both building and bridge work have been emphasized at every opportunity in these columns; no doubt, in the minds of some, too often. However, in view of the great strides made in architectural treatment of concrete structures in the last few months, we feel that we are entirely justified in our course.

At the recent annual meeting of the American Concrete Institute, Mr. Irving K. Pond, F. A. I. A., presented a paper entitled "Concrete—A Medium of Esthetic Expression," which shows that the architectural profession is beginning to realize that in concrete they have at their disposal a material with almost unlimited possibilities of archtectural treatment, as we have always contended. It is with a sense of keen satisfaction that we are able to reprint here, abstracts from Mr. Pond's paper, which so convincingly sets forth the possibilities of concrete.

"Although the use of concrete goes back into antiquity, plastic architecture would seem to be in the veriest infancy, and would seem also to be asking the genius of this age to give it perfect expression and make it worthy to stand with the architecture of the past and the yet-to-come. Though the past be examined for precedent, little will be found. Rome used concrete in bulk, but undeniable evidence of a scientific use of the material is wanting. Rome applied superficially the arts of other times and countries, but of itself left to posterity only monuments expressive of a highly temperamental force, breathing little or nothing of spirituality. Persia covered with stucco or veneered with beautiful tiles her masses of crude masonry. The Arabians and the Moors expressed their emotionalism in a plastic architecture decorated with a skim coat of ornamental plaster or an incrustation of tile, intricate in pattern and beautiful in color. The concrete of the mass was but mud, and the science of building was unknown. In such material beautiful day dreams were realized only to crumble when the spell was past. The Spanish missions were built with rare feeling for mass and light and shade; but feeling swayed and science did not guide. With the science of today to guide and the art experience of the past to illumine, into what logical, noble and beautiful forms should not concrete shape itself, to the end of an enduring, spiritualized architecture.

"The possibilities, even the esthetic possibilities, within the range of reinforced concrete construction can hardly be over-estimated. Little beyond the introductory chapter has been written in the history of reinforced concrete, and every advance in the science of its manufacture and use will signal an advance along the line of artistic application.

"Except in well-defined types, designed to serve certain well-defined uses, it is impracticable so to carry masonry construction beyond and behind the facade as to result in a homogeneous structure—wanting which, architecture becomes but a hollow sound. The architecture of a reinforced plastic material may, and logically will, express itself throughout the entire structure to the remotest core. The unity, the truth, the harmony of the whole may in every part be manifested. Therefore, again, the possibilities inherent in concrete present themselves alluringly to the architect to whom the art means as much as does the science of building.

"When architects relieve themselves of the notion that monumental architecture, for example, consists solely in a row of classical columns superimposed upon a basement, it will be a wholesome day for the art they profess to practice. Probably ignorance, inability and self-distrust in the architectural ranks will remove to some more or less remote future the development of a monumental architecture expressing itself in new forms fashioned in new materials. Yet it is possible that, in this, as in other ages, commercialism, itself so devoid of esthetic tendencies, will pave the way to the realization of an esthetic ideal. A material which holds in itself the qualifications for commercial use will in that very use reveal its esthetic possibilities. No material which puts into the hand of the architect power to produce permanent mass and form, and add the enrichment of light and shade, color and texture, will long be ignored when science has made its use commercially possible. It would, then, seemingly remain only for science to demonstrate the practical value of reinforced concrete, in respect to its physical properties, and art must unfold whatever it holds of beauty.

"It is not inconceivable that ornamental terra cotta and tile, beautiful in color and texture, and also sculptured stone will be called upon to embellish and distinguish, though not in any manner to clothe or conceal, the concrete structure. The presence of these materials may be needed as a saving grace in these early days of design in concrete, to save the designers from a too brutal conception of the forms they deem the material must necessarily take. This is an unfortunate, though marked tendency now, in what should be a refined and restrained domestic architecture, to shape concrete, and its lath and plaster imitations, into the crude, though characteristic, forms of the old mission work. It is needless to say that these forms have no meaning outside of their original environment and would not have existed there but for the exigencies of the case—the crude nature of the materials procurable and the absence of all skilled labor.

"But today, with art and science co-operating, it would seem as though architecture were on the verge of an awakening. Commercial architecture with us is beginning to feel the thrill. Abroad monumental architecture as well is showing signs of a renewed joy in life, and structural concrete, both of itself and embellished with richer materials, furnishes the new and seemingly adequate medium of architectural expression."

Concrete Practice No. 12

Detail Plans of Standard Concrete Box and Arch Culverts, St. Louis and San Francisco.

BY A. M. WOLF, C. E.

The St. Louis and San Francisco Railroad, located for the most part in a timber country, has and is still using timber trestles mainly for minor stream and lowland crossings. At the present time short trestles are being eliminated and concrete box and arch culverts constructed in their stead. In order to make this replacement work as economical and uniform in design as possible the engineering department has just recently completed sheets of standard box and circular arch culverts, plans which cover a great number of different sized openings. The tables accompanying the standard plans are so complete that any desired dimension, quantity, or piece of reinforcing required for any particular sized culvert can be readily found without difficulty. Dealing with nearly 80 different culverts, these standards should prove of exceptional value to the designer and bridge engineer.

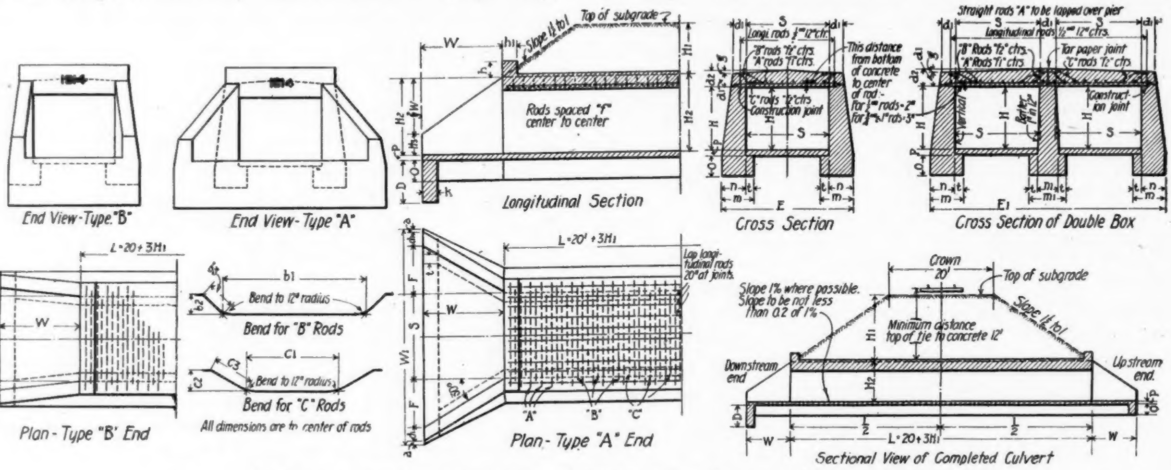


Fig. 1. Detail Plan for Standard Reinforced Concrete Box Culverts, St. L. & S. F. R. R.

REINFORCED CONCRETE BOX CULVERTS.

Reinforced concrete single and double box culverts of two types as regards wing walls are built. The Type A end having wings flared at 30 degrees with the center line of culvert, while the Type B end has straight wing walls. This latter type is used where there is any probability of future extension of the culvert, and also for all cattle passes and road crossings.

DESIGNING LOADS AND STRESSES.

The box culverts are designed for Cooper's E-55 live loading with 50 per cent added for impact with a minimum depth of ballast of 12 in. below base of rail or a maximum depth of embankment of 30 ft. For depths of fill from 30 to 40 ft. the thickness of cover is increased 1 in. for each 5 ft., for greater depths special designs are made.

The unit stresses used are:

Steel in tension: 15,000 to 16,000 lbs. per sq. in.

Concrete in crossbending compression, 700 lbs. per sq. in.

Shear in slabs for concrete alone, 40 lbs. per sq. in.

The concrete used is of a 1:2:4 and 1:2½:5 mix, with fine and coarse aggregates of such relative proportions as to insure maximum density. The coarse aggregate may be either crushed stone, gravel or selected slag which is retained on a ¼-in. diameter mesh screen and passing a 1-inch ring, graded from smallest to largest particles. This aggregate must be clean, hard, durable and free from all deleterious matter. Aggregates containing dust, soft or elongated particles are not used.

The reinforcing bars used are of a deformed bar type, either medium or high carbon steel, of new billet stock meeting the manufacturers' standard specifications of 1914, free from grease, dirt, rust in flakes or anything that might weaken the bond of concrete. Whenever splices in reinforcement are necessary at points other than those indicated on plans, the bars are lapped and spliced on the basis of the safe bond stress and stress in reinforcement at the point of splice, no splices to be made at points of maximum stresses in bars.

The allowable bearing on footings is ordinarily 2½ or 3 tons per sq. ft., the depth of footings being increased over those shown, if necessary to reach material which will bear this load.

DETAILS OF DESIGN.

From Figures 1 and 2 it will be seen that the standards cover culverts varying from 3x2 ft. to 20x16 ft., in the most part by 2 ft. intervals, thus giving a variation in openings of from 6 to 320 sq. ft. The side and wing walls are of plain concrete with inner faces vertical and the backs battered, with a projecting footing on the inside to support the plain concrete paving slab, varying in thickness from 4 to 12 in. depending on the size of culvert. The pavings end in a baffle wall at both ends, the baffle at the upstream end being carried down to bottom of wall footings and the downstream baffle considerably deeper as shown by the plan Figure 1 and the table Figure 2. The culvert is given a slope of 1 per cent where possible and in no case less than 0.2 per cent to provide a good flow through the culvert. Where the bottom is of hard material and not subject to scour the paving is omitted.

At the top of side walls is a stepped construction joint

DIMENSIONS AND CONTENTS

SIZE S×H	AREA OPENING SQ FT	H_2	E	E_1	COVER d_1	COVER d_2	COVER g	COVER ROD SPACE f
3×2	6	2'9"	4'9"	8'6"	9"	10"	1"	5"
3×3	9	3'9"	5'	8'9"	•	•	•	•
4×2	8	2'10"	6'	10'10"	10"	11"	1"	4"
4×3	12	3'10"	6'3"	11'1"	•	•	•	•
4×4	16	4'10"	6'6"	11'4"	•	•	•	•
6×2	12	3'3"	9'	16'3"	15"	16"	1"	6"
6×4	24	5'3"	9'6"	16'9"	•	•	•	•
6×6	36	7'3"	10'	17'3"	•	•	•	•
8×4	32	5'6"	12'6"	22'	18"	19"	1"	4½"
8×6	48	7'6"	12'9"	22'3"	•	•	•	•
8×8	64	9'6"	13'	22'6"	•	•	•	•
10×4	40	5'9"	15'3"	27'	21"	22½"	1¼"	3½"
10×6	60	7'9"	15'6"	27'3"	•	•	•	•
10×8	80	9'9"	15'9"	27'6"	•	•	•	•
10×10	100	11'9"	16'	28'3"	•	•	•	•
12×4	48	6'1"	18'	32'1"	25"	27"	2"	3"
12×6	72	8'1"	18'3"	32'4"	•	•	•	•
12×8	96	10'1"	18'6"	32'7"	•	•	•	•
12×10	120	12'1"	19'	33'1"	•	•	•	•
12×12	144	14'1"	20'	34'1"	•	•	•	•
14×6	84	8'5"	21'6"	37'11"	29"	31"	2"	4½"
14×8	112	10'5"	21'9"	38'2"	•	•	•	•
14×10	140	12'5"	22'	38'5"	•	•	•	•
14×12	168	14'5"	22'5"	38'6"	•	•	•	•
14×14	196	16'5"	23'6"	39'11"	•	•	•	•
16×6	96	8'8"	24'3"	42'11"	32"	34½"	2½"	4"
16×8	128	10'8"	24'6"	43'2"	•	•	•	•
16×10	160	12'8"	24'9"	43'5"	•	•	•	•
16×12	192	14'8"	25'	43'8"	•	•	•	•
16×14	224	16'8"	25'6"	44'2"	•	•	•	•
16×16	256	18'8"	27'	45'8"	•	•	•	•
18×6	108	9'	27'6"	48'6"	36"	38½"	2½"	5½"
18×8	144	11'	27'9"	48'9"	•	•	•	•
18×10	180	13'	28'	49'	•	•	•	•
18×12	216	15'	28'3"	49'3"	•	•	•	•
18×14	252	17'	28'6"	49'6"	•	•	•	•
18×16	288	19'	28'9"	49'9"	•	•	•	•
20×6	160	11'4"	30'6"	55'10"	40"	43"	3"	3½"
20×10	200	13'4"	30'9"	56'1"	•	•	•	•
20×12	240	15'4"	31'	56'4"	•	•	•	•
20×14	280	17'4"	31'6"	56'10"	•	•	•	•
20×16	320	19'4"	32'	55'4"	•	•	•	•

* Make h = 12" where no filling occurs other than ballast

Fig. 2. Dimensions and Contents Box Culverts, St. L. & S. F. R. R.

so that the cover slab, resting upon them will resist the tendency of the walls to move in at the top. The tops of wings are sloped off at a slope of 1½ to 1 with a small vertical position at the ends. The wings at both ends of culvert are made the same length.

The cover slabs are reinforced with bent and straight bars transversely, so placed as to have them alternate, the bent bars to aid in taking the shearing stresses. Two different types of bent bars are used as shown in Fig. 1. These bars are placed so as to give a distance of 2 in. from bottom of concrete to center of bars for ½ in. bars and 3 in. for larger bars. Longitudinal distributing bars consist of ½ in, sq. bars spaced 12 in. centers for all culverts. For double box culverts (See Fig. 1) the slabs are separated by a tar paper joint over center wall and only the bottom bars are lapped over the pier. The slabs varying in thickness from 10 in. at the center for 3 ft. span to 43 in. for a 20 ft. span, the tops being sloped off from center to sides from 1 to 3 in. depending on the span. At the ends of barrel a plain concrete parapet wall from 1 to 2 ft. high is formed to retain the fill. The year of construction is indicated at each end by setting a date plate in the forms at the time of pouring the concrete.

The table (Figure 2) in conjunction with the plans (Figure 1) gives all the necessary data for construction. After construction, however, the district engineer furnishes a plan of each structure showing the actual dimensions as constructed as a matter of permanent record.

FINISH.

All exposed surfaces are given a wash coating of one part cement and three parts sand after the forms are removed and all exposed edges are rounded to a 1 in. radius.

WATERPROOFING.

All surfaces exposed to fill are painted two coats of coal tar paint of the following proportions, by volume:

Old Process Coal Tar	16 parts
Portland Cement	4 parts
Kerosene Oil	1 part

The cement and oil to be mixed and stirred into the melted coal tar. When cool the mixture is thinned somewhat with oil so as to flow under the brush, but excess oil is at all times avoided. At street and important road crossings the slabs are waterproofed by the membrane method instead of that given above.

PLAIN CONCRETE ARCH CULVERTS.

Plain concrete semi-circular arch culverts are used over stream and roadway crossings where a larger waterway or greater under-clearance is required than is provided by the box culvert; A indicated in the table Figure 4 the designs vary from 10 ft. span and 9 ft. height with a waterway of 79 sq. ft. to 30 ft. span and 27 ft. height with a waterway of 713 sq. ft.

DESIGNING LOADS.

The arch culverts are designed for Cooper's E-55 loading and minimum fills of 4 ft. for 10 to 20 ft. spans and 6 ft. for 22 to 30 ft. spans. The concrete used for this type of culvert is of a 1:3:6 mixture with coarse aggregate varying from ¼ in. to 2½ in. in smallest diameter.

The footings are proportioned for ordinary material good for a load of 2½ to 5 tons per sq. ft. Where soil of this character cannot be obtained, piling is driven about 3 ft. centers, or one pile to each 9 sq. ft. of bearing area.

DETAILS OF DESIGN.

The abutment walls rest on footings projecting beyond the neatwork both inside and out, and have vertical faces inside and battered on the outside from 3 to 4 in. in 1 ft. as shown in Figures 3 and 4. Where the bottom is soft material subject to scour a 6 in. paving slab is used with cross struts the depth of the footing below at intervals of 12 ft. for 10 to 20 feet spans, and 15 ft. for 22 to 30 ft. spans. Expansion joints ½ in. wide filled with coal tar are formed over these struts so as to separate the paving into smaller units to avoid shrinkage and temperature cracks. At the downstream end a baffle or bulkhead wall is carried down some distance below the bottom of side-wall footings while at the upstream end it extends only to the bottom of footing. Where the bottom is of hard material not subject to scour the paving, struts and bulkhead walls are omitted.

The abutment walls are constructed up to the springing line of arch and a keyed construction joint formed at the top. Upon these the semi-circular arches of the shapes shown in plans (Figure 3) and table (Figure 4) are constructed. The crown thicknesses of arch rings vary from 1 ft. 6 in. for 10 ft. spans to 2 ft. 6 in. for 30 ft. spans.

A plain concrete spandrel or parapet wall is formed at each end of the culvert barrel, with a date plate a crown.

The wing walls having a 30 degree flare are 2 ft. 4 in. wide at the top with the back battered same as abut-

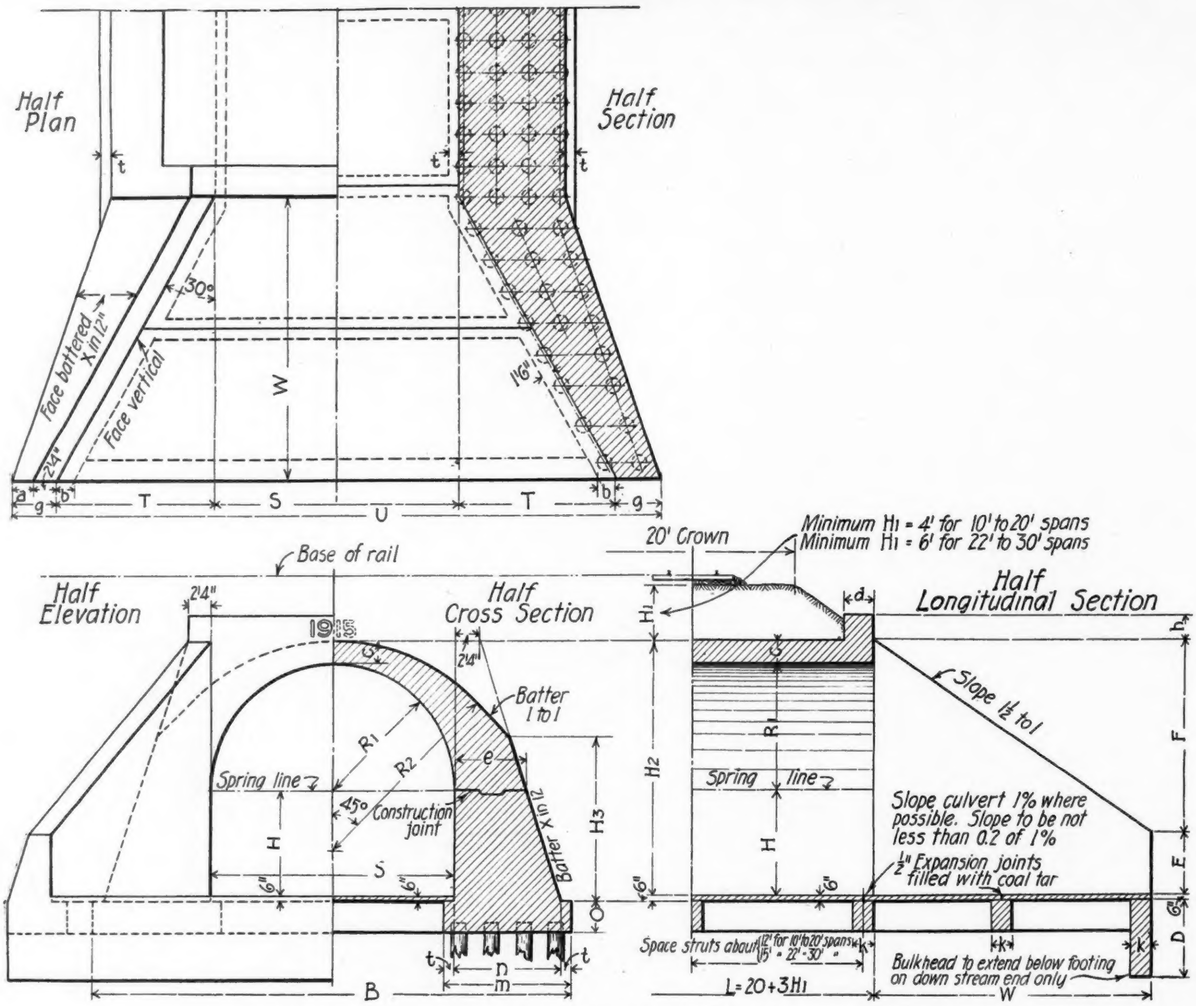


Fig. 3. Detail Plan for Standard Plain Concrete Arch Culverts, St. L. & S. F. R. R.

ments and the face vertical. The tops of wings have a 1½ to 1 slop. All the details of culverts are shown in Figures 3 and 4.

CONSTRUCTION.

The bench or abutment walls, wing and parapet walls are poured in horizontal layers, special care being taken to have the wing walls made monolithic with the bench and parapet walls and the parapets monolithic with the arch ring. The arch rings are cast in complete sections of a full semi-circle, each section being placed in one operation.

Surface finish and waterproofing for arch culverts are same as for box culverts.

SPECIFICATIONS.

The following abstracts from the standard specifications of this road for plain and reinforced concrete are of interest.

PLACING OF CONCRETE.

Concrete after the completion of the mixing shall be handled rapidly to the place of final deposit, and under no circumstances shall concrete be used that has partially set before final placing.

The concrete shall be deposited in such manner as will prevent the separation of the ingredients, and permit the most thorough compacting. It shall be compacted by working with a straight shovel or slicing tool kept moving up and down until all the ingredients have settled in their proper place and all the surplus water is forced to the surface. In general, except in arch work and reinforced slabs and floors, all concrete must be deposited in horizontal layers of uniform thickness throughout. Care must be taken that the laitance (fine chalklike substance rising to the surface of wet mixture) does not becomes excessive during pouring. Should this appear it should be worked back into the mass of concrete, or if it cannot be entirely worked into the mass it should be removed before a new layer of concrete is added, for while this material has within it the best bonding material of the cement concrete will not adhere to it after it coats over a surface.

Before depositing concrete the forms shall be thoroughly wetted (except in freezing weather) or oiled, and the space to be occupied by the concrete cleared of débris.

Before placing new concrete on or against concrete which has set, the surface of the latter shall be roughened, thoroughly cleansed, drenched and slushed with a mortar consisting of one part Portland cement and not more than two parts fine aggregate.

The face of concrete exposed to premature drying shall be kept wet for a period of at least three days.

FREEZING WEATHER.

Concrete shall not be mixed or deposited at a freezing temperature, unless special precautions, approved by the engineer, are taken to avoid the use of materials covered with ice crystals or containing frost and to provide means to prevent the concrete from freezing.

RUBBLE CONCRETE.

While the concrete is to be deposited in massive work, clean large stones, evenly distributed, thoroughly bedded and entirely surrounded by concrete, may be used, at the option of the engineer.

FORMS.

Forms shall be substantial and unyielding and built so that the concrete shall conform to the designed dimensions and contours, and so constructed as to prevent the leakage of mortar.

The forms shall not be removed until authorized by the engineer.

For all important work the lumber used for face work shall be dressed to a uniform thickness and width; shall be sound and free from loose knots and secured to the studding or uprights in horizontal lines.

For backings and other rough work undressed lumber may be used.

Where corners of the masonry and other projections liable to injury occur, suitable moldings shall be placed in the angles of the forms to round or bevel them off.

Lumber once used in forms shall be cleaned before being used again.

The reinforcement shall be carefully placed in accordance with the plans, and adequate means shall be provided to hold it in its proper position until the concrete has been deposited and compacted.

PLACING STRUCTURE IN SERVICE.

Structures of concrete shall not be placed under load within 30 days of completion.

DETAILS OF CONSTRUCTION—JOINTS IN CONCRETE.

Concrete structures, wherever possible shall be cast at one operation, but when this is not possible, the resulting joint shall be formed where it will least impair the strength and appearance of the structure.

Girders and slabs shall not be constructed over freshly formed walls or columns without permitting a period of at least four hours to elapse to provide for settlement or shrinkage in the supports. Before resuming work the tops of such walls or columns shall be cleaned of foreign matter.

A triangular shaped groove shall be formed at the surface of the concrete at vertical joints in walls and abutments.

SURFACE FINISH.

Except where a special surface finish is required a spade or special tool shall always be worked between the concrete and the form to force back the coarse aggregates and produce a mortar face. On removal of forms, exposed faces shall be given a coat of cement wash mixed 1 part cement to 2 of sand and applied with a brush or broom.

TOP SURFACES.

Top surfaces shall generally be "struck" with a straight edge or "floated" after the coarse aggregates have been forced below the surface.

SIDEWALK FINISH.

Where a "sidewalk finish" is called for on the plans, it shall be made by spreading a layer of 1:2 mortar at least ¾ in. thick, troweling the same to a smooth surface. This finishing coat shall be put on before the concrete has taken its initial set.

DEPOSITING CONCRETE UNDER WATER.

In depositing concrete under water special care shall be exercised to prevent the cement from floating away.

COFFERDAMS.

Cofferdams shall be sufficiently tight to prevent flow of water through the pit, and the water in the pit shall be still. When the forms rest on rock bottom under water, the contractor shall employ a diver to see that the forms make a close connection with the rock bottom and in case it is impossible to fit the forms to the irregularities of the bottom, sand bags will be placed around the outside of the forms by a diver to prevent current.

DIMENSIONS AND CONTENTS

Size S×H	Area of opening in sq. ft.	H2	B	Arch Ring			Abutment							Wing Walls								Head Walls		Bulkhead & Paving		Contents				No. of Piling	
																										Unpaved		Paved			
				c	R1	R2	H3	Batter X	e	n	m	t	O	W	T	a	b	g	U	E	F	h	d	D	k	Per lin. foot of barrel	4 wing walls & parapets	Per lin. foot of barrel	4 wing walls & parapets	Per lin. foot of barrel	4 wing walls
10×4	79	10'6"	22'2"	1'6"	5'	10'10¼	7'2½	3"	3'11½"	5'1"	7'1"	1'	2'6	9'9"	5'7½"	1'1½	1'9"	3'5½	28'2"	4'	6'6"	2'	2'	5'	1'9"	4.70	66.02	4.99	85.91	1⅓	28
10×6	99	12'6"	23'2"	"	"	"	9'2½	"	"	5'7"	7'7"	1'	"	12'9"	7'4¼	"	"	"	31'7½	4'	8'6"	"	"	"	"	5.58	94.24	5.87	118.91	"	36
10×8	119	14'6"	24'2"	"	"	"	11'2½	"	"	6'1"	8'1"	1'	"	15'9"	9'1"	"	"	"	35'1"	4'	10'6"	"	"	"	"	6.54	128.16	6.83	158.02	"	44
12×4	104	11'7"	25'2¾	1'7"	6'	12'	7'5¾	3¼"	4'4¾	5'7⅜	7'7⅜	1'	2'6"	11'4½	6'6¾	1'2⅝	1'9"	3'6⅝	32'2¾	4'	7'7"	2'	2'	5'	1'9"	5.44	84.23	5.80	109.16	1⅓	32
12×6	128	13'7"	26'3¾	"	"	"	9'5¾	"	"	6'1⅞	8'1⅞	1'	"	14'4½	8'3½	"	"	"	35'8¼	4'	9'7"	"	"	"	"	6.41	116.67	6.77	146.82	2	44
12×8	152	15'7"	27'4¾	"	"	"	11'5¾	"	"	6'8⅜	8'8⅜	1'	"	17'4½	10'0¼	"	"	"	39'1¾	4'	11'7"	"	"	"	"	7.46	155.19	7.82	190.95	"	56
14×4	133	12'8"	27'9¾	1'8"	7'	13'2¼	7'10¼	3¼"	4'8¼	5'10⅛	7'10⅛	1'	2'6"	13'	7'6"	1'2⅝	1'9"	3'6⅝	36'1¼	4'	8'8"	2'	2'	6'	2'	6.10	102.58	6.54	138.44	2	40
14×6	161	14'8"	28'10¾	"	"	"	9'10¼	"	"	6'5⅜	8'5⅜	1'	"	16'	9'2¾	"	"	"	39'6¾	4'	10'8"	"	"	"	"	7.10	138.21	7.54	180.25	"	48
14×8	189	16'8"	29'11¾	"	"	"	11'10¼	"	"	6'11⅛	8'11⅛	1'	"	19'	10'11½	"	"	"	43'0¼	4'	12'8"	"	"	"	"	8.20	180.26	8.64	228.92	"	60
16×4	164	13'9"	30'11½	1'9"	8'	14'4¾	8'1"	3½"	5'2"	6'5¾	8'5¾	1'	2'9"	13'1½	7'7"	1'7¼	2'	3'11¼	39'0½	5'	8'9"	2'3"	2'6"	6'	2'	7.10	127.93	7.63	167.85	2	44
16×6	196	15'9"	32'1½	"	"	"	10'1"	"	"	7'0¾	9'0¾	1'	"	16'1½	9'3¾	"	"	"	42'6"	5'	10'9"	"	"	"	"	8.21	169.41	8.74	215.93	"	56
16×8	228	17'9"	33'3½	"	"	"	12'1"	"	"	7'7¾	9'7¾	1'	"	19'1½	11'0½	"	"	"	45'11½	5'	12'9"	"	"	"	"	9.42	218.22	9.95	271.70	"	68
18×4	199	14'10"	33'7½	1'10"	9'	15'7½	8'5¾	3½"	5'6"	6'9¾	8'9¾	1'	2'9"	14'9"	8'6¼	1'7¼	2'	3'11¼	42'11"	5'	9'10"	2'3"	2'6"	7'	2'	7.88	152.22	8.49	202.07	2	48
18×6	235	16'10"	34'9½	"	"	"	10'5¾	"	"	7'4¾	9'4¾	1'	"	17'9"	10'3"	"	"	"	46'4½	5'	11'10"	"	"	"	"	9.05	197.56	9.66	254.64	2⅔	60
18×8	271	18'10"	35'11½	"	"	"	12'5¾	"	"	7'11¾	9'11¾	1'	"	20'9"	11'11¾	"	"	"	49'10"	5'	13'10"	"	"	"	"	10.30	250.15	10.91	314.96	"	72
20×6	277	18'	38'2¾	2'	10'	17'2½	10'11¼	3¾"	6'1"	8'1⅜	10'1⅜	1'	3'	19'6"	11'3"	1'8⅝	2'3"	4'0⅝	50'7¼	5'	13'	2'3"	2'6"	7'	2'	10.55	244.39	11.25	310.76	2⅔	72
20×8	317	20'	39'5¾	"	"	"	12'11¼	"	"	8'8⅞	10'8⅞	1'	"	22'6"	12'11¾	"	"	"	54'0¾	5'	15'	"	"	"	"	11:95	305.27	12.65	379.86	"	88
20×10	357	22'	40'8¾	"	"	"	14'11¼	"	"	9'4⅜	11'4⅜	1'	"	25'6"	14'8½	"	"	"	57'6¼	5'	17'	"	"	"	"	13.43	374.90	14.13	458.14	"	104
22×6	322	19'2"	40'11¾	2'2"	11	18'9⅜	11'7"	3¾"	6'5½"	8'5⅞	10'5⅞	1'	3'	21'3"	12'3¼	1'8⅝	2'3"	4'0⅝	54'7¾	5'	14'2"	2'3"	2'6"	8'	2'3"	11.70	281.11	12.44	366.78	2⅔	80
22×8	366	21'2"	42'2¾	"	"	"	13'7"	"	"	9'1⅜	11'1⅜	1'	"	24'3"	14'	"	"	"	58'1¼	5'	16'2"	"	"	"	"	13.15	347.11	13.89	442.15	"	96
22×10	410	23'2"	43'5¾	"	"	"	15'7"	"	"	9'8⅞	11'8⅞	1'	"	27'3"	15'8¾	"	"	"	61'6¾	5'	18'2"	"	"	"	"	14.70	422.37	15.44	527.15	"	112
24×6	370	20'3"	44'6"	2'3"	12'	20'	11'8"	4"	7'1"	9'3"	11'3"	1'	3'	21'4½	12'4"	2'2"	2'3"	4'6"	57'8"	6'	14'3"	2'6"	3'	8'	2'3"	13.03	326.39	13.84	417.20	2⅔	88
24×8	418	22'3"	45'10"	"	"	"	13'8"	"	"	9'11"	11'11"	1'	"	24'4½	14'0¾	"	"	"	61'1½"	6'	16'3"	"	"	"	"	14.60	399.05	15.41	499.46	"	104
24×10	466	24'3"	47'2"	"	"	"	15'8"	"	"	10'7"	12'7"	1'	"	27'4½	15'9½	"	"	"	64'7"	6'	18'3"	"	"	"	"	16.26	483.05	17.07	593.49	"	120
24×12	514	26'3"	48'6"	"	"	"	17'8"	"	"	11'3"	13'3"	1'	"	30'4½	17'6¼	"	"	"	68'0½	6'	20'3"	"	"	"	"	18.03	575.65	18.84	696.46	"	136
26×6	421	21'4"	47'6½	2'4"	13'	21'3"	12'0½	4"	7'5¼	9'7¼	11'11¼	1'2"	3'6"	23'	13'3¼	2'2"	2'6"	4'6"	61'6½	6'	15'4"	2'6"	3'	9'	2'6"	14.60	398.17	15.60	515.95	2⅔	96
26×8	473	23'4"	48'10½	"	"	"	14'0½	"	"	10'3¼	12'7¼	"	"	26'	15'	"	"	"	65'	6'	17'4"	"	"	"	"	16.25	468.91	17.25	597.87	"	116
26×10	525	25'4"	50'2½	"	"	"	16'0½	"	"	10'11¼	13'3¼	"	"	29'	16'9"	"	"	"	68'6"	6'	19'4"	"	"	"	"	18.00	560.76	19.00	701.35	"	132
26×12	577	27'4"	51'6½	"	"	"	18'0½	"	"	11'7¼	13'11¼	"	"	32'	18'5¾	"	"	"	71'11½	6'	21'4"	"	"	"	"	19.83	663.36	20.83	815.84	"	152
28×6	475	22'5"	50'3½	2'5"	14'	22'6"	12'4¾	4"	7'9¾	9'11¾	12'3¾	1'2"	3'6"	24'7½	14'2½	2'2"	2'6"	4'6"	65'5"	6'	16'5"	2'6"	3'	9'	2'6"	15.72	434.19	16.80	563.45	3⅓	108
28×8	531	24'5"	51'7½	"	"	"	14'4¾	"	"	10'7¾	12'11¾	"	"	27'7½	15'11¼	"	"	"	68'10½	6'	18'5"	"	"	"	"	17.43	521.60	18.51	662.49	"	124
28×10	587	26'5"	52'11½	"	"	"	16'4¾	"	"	11'3¾	13'7¾	"	"	30'7½	17'8"	"	"	"	72'4"	6'	20'5"	"	"	"	"	19.22	619.47	20.30	772.14	"	140
28×12	643	28'5"	54'3½	"	"	"	18'4¾	"	"	11'11¾	14'3¾	"	"	33'7½	19'5"	"	"	"	75'10"	6'	22'5"	"	"	"	"	21.12	728.27	22.20	893.53	"	160
30×6	533	23'6"	53'	2'6"	15'	23'9"	12'9"	4"	8'2"	10'4"	12'8"	1'2"	3'6"	26'3"	15'1¾	2'2"	2'6"	4'6"	69'3½	6'	17'6"	2'6"	3'	10	2'6"	16.88	484.12	18.04	631.57	3⅓	116
30×8	593	25'6"	54'4"	"	"	"	14'9"	"	"	11'	13'4"	"	"	29'3"	16'10½	"	"	"	72'9"	6'	19'6"	"	"	"	"	18.65	577.45	19.81	737.19	"	132
30×10	653	27'6"	55'8"	"	"	"	16'9"	"	"	11'8	14'	"	"	32'3"	18'7¼	"	"	"	76'2½	6'	21'6"	"	"	"	"	20.50	680.42	21.66	852.87	"	152
30×12	713	29'6"	57'	"	"	"	18'9"	"	"	12'4"	14'8"	"	"	35'3"	20'4¼	"	"	"	79'8½	6'	23'6"	"	"	"	"	22.43	795.23	23.59	980.97	"	172

Fig. 4. Dimensions and Contents Arch Culverts, St. L. & S. F. R. R.

METHOD OF PLACING.

The concrete shall be deposited in place either by means of a drop-bottom bucket or a tremie, and shall not be allowed to fall through the water.

Where a bucket is used, it should be carefully lowered to the bottom and raised to the surface, so as to cause as little disturbance as possible to the water.

Where a tremie is used, it should be kept filled with concrete up to the top of the water level, and the discharge should be kept buried in the freshly deposited mass to prevent emptying, and raised a few inches at a time as the filling progresses.

The surface of the concrete must be kept as nearly level as possible to avoid the formation of pockets.

CONTINUOUS PLACING.

Where concrete is not deposited continuously, all sediment should be removed from the surface of the concrete by pumping or otherwise, before depositing fresh concrete.

COMMENT.

The writer is indebted to Mr. F. G. Jonah, Chief Engr. St. L. & S. F. R. R., for plans and data used in this article.

Circular and Egg-Shaped Reinforced Concrete Pipe

Showing Results of Tests of the Two Types from a Paper Presented Before the American Concrete Institute

by Alfred T. Goldbeck

This paper gives the results of a series of tests on concrete sewer pipe which had not previously been used in Philadelphia. The circular pipe tested was 36 in. in diameter and 4 in. thick; the egg-shaped pipe was 36 in. high and 24 in. wide, 3⅛ in. thick with a flat base 8 in. wide. The concrete was mixed in the proportions of 1:2:3½ with both trap rock and slag as the coarse aggregate. The reinforcement consisted of triangular wire mesh. The pipes both air and steam cured were required to withstand an imposed load of 1000 lbs. per sq. in. before the first hair-crack showed.

The following are the conclusions drawn by the author:

1. Reinforced concrete pipes, when properly made and properly cured, are very satisfactory for the construction of sewers.
2. The use of a concrete cradle greatly increases the stiffness of the pipe and raises the load under which initial cracking takes place.
3. For sections of the size tested and for smaller sections, the placing of the reinforcing near the inner face throughout the entire circumference seems to be justified.
4. The matter of curing should be very carefully controlled, as much stronger pipes will result if care is taken to keep them thoroughly wet, preferably for a period of two weeks.

Reinforced Column Design Formulae

The Engineers' Club of St. Louis has appointed a committee to investigate the status of the provisions in the present St. Louis building code. This committee recommends that all reinforced concrete columns shall contain from 1 to 4 per cent longitudinal steel stayed against buckling either by hooping or by bands. The hooping shall consist of steel rods of uniform pitch not exceeding 4 in. or one-fourth of the core diameter, nor less than 2 in., and the volume of hooping must not be less than 0.75 per cent of the concrete inclosed by the hooping. The safe load (P) on the column in terms of area of concrete within the hooping (C) and the total area of longitudinal bars (A) can be found by the formula, $P = 750\ (C + 15A)$. For banded columns the bands shall have a minimum cross-section of 0.05 sq. in. and be spaced not farther apart than twelve times the diameter or least side of longitudinal rods—in no case more than 12 in. The load on a banded column shall not exceed that indicated by the formula, $P = 500\ (C + 15A)$.

Editor's Note—These proposed column formulæ are decidedly more conservative than the ones now used by the St. Louis Building Department and are more nearly in accordance with the results of tests. According to the new formula for spiral hooped columns the minimum allowable unit stress is 863 lbs. per sq. in. for 0.75 per cent spiral and 1 per cent longitudinal steel, with a maximum of 1,200 lbs. per sq. in. for 4 per cent longitudinal steel as against corresponding values of 1180 and 1760 lbs. per sq. in. allowed by the old code. This proposed radical reduction in allowable loads is an indication that engineers feel that the present code is entirely too liberal.

Current Prices—Concrete Materials

Portland Cement—On account of the great amount of cement sold for future delivery, the prices will only become normal again, should a great amount of construction work be undertaken shortly. In the West there seems to be an optimistic outlook, due to the great amount of concrete highway construction contemplated. Prices given f. o. b. cars at points named, including cloth sacks, for which, in general, 40c per barrel (4 sacks) is refunded on return in good condition. Prices per barrel (including 4 cloth sacks) are as follows: Boston, $1.46; New York, $1.23; Chicago, $1.46 to $1.55; Pittsburgh, $1.40; New Orleans, $1.58 on dock; Memphis, $1.75; Cleveland, $1.54; Detroit, $1.59; Indianapolis, $1.58; Peoria, $1.54; Cincinnati, $1.59; Columbus, $1.58; Toledo, $1.59; Cleveland, $1.54; St. Louis, $1.50; Milwaukee, $1.58; Minneapolis and St. Paul, $1.63; Kansas City, $1.48; Omaha, $1.48; Spokane, $1.75; Seattle, $2.20; Tacoma, $2.20; Portland, Ore., $2.15; Duluth, $1.72.

Crushed Stone—1½-inch stone, prices per cubic yard, f. o. b. cars in carload lots, unless otherwise specified. Boston, 80c per ton at the quarry; New York, 80c to 85c, in full cargo lots at the docks; Chicago, $1.15; Spokane, $1.00; Portland, Ore., $1.15; Seattle, $1.50.

Gravel—Prices given are per cubic yard, f. o. b. cars in carload lots unless otherwise noted. New York, 85c in full cargo lots at docks; Chicago, $1.15; Spokane, $1.00; Portland, Ore., 85c; Seattle, 75c; Tacoma, 75c.

Sand—Prices are per cubic yard, f. o. b. cars in carload lots unless otherwise indicated. New York, 50c, full cargo lots at docks; Chicago, $1.15; Spokane, 75c; Seattle, 75c; Portland, Ore., 85c; Tacoma, 75c.

Reinforcing Bars—The demand for and the prices of bars has not increased and May deliveries will be made on a basis of $1.20 per cwt., Pittsburgh, with prevailing extras for bars under ¾-inch or base. The following are quotations on base bars per 100 lbs. for mill shipments from other points, f. o. b. cars: New York, $1.36; Philadelphia, $1.35; Chicago, $1.38; Spokane, $2.20; Seattle, $1.85; Portland, Ore., $1.90; Tacoma, $1.85.

Shipments from stock are being made at the following prices per cwt., f. o. b. cars; Pittsburgh, $1.65; New York, $1.95; Cleveland, $1.80; St. Louis, $1.90; Chicago, $1.85; Spokane, $2.50; Tacoma, $2.20; Portland, Ore., $2.15; Seattle, $2.20.

Metal Clips for Supporting Bars—$4.50 to $6.50 per 1,000, depending on size.

For the majority of the prices given we are indebted to the Universal Portland Cement Co., Sandusky Portland Cement Co., Concrete Steel Co., American Sand & Gravel Co., Chicago, and F. T. Crowe & Co., Seattle, Portland, Spokane and Tacoma.

Reinforcing bars for mill shipments are in general sold on a Pittsburgh basis; this is, at the Pittsburgh quotations plus the freight to the point in question, and with the following list of freight rates on finished material and the Pittsburgh quotations given, the prices of bars at any of the points listed can be readily computed.

From Pittsburgh, carloads, per 100 pounds to:

Albany	16 cents	Columbus	12 cents
New York	16 cents	Cincinnati	15 cents
Philadelphia	15 cents	Louisville	18 cents
Baltimore	14½ cents	Chicago	18 cents
Boston	18 cents	Richmond	20 cents
Buffalo	11 cents	Denver	85 cents
Norfolk	20 cents	St. Louis	23 cents
Cleveland	10 cents	New Orleans	30 cents
Minneapolis	32 cents	Indianapolis	17 cents
Kansas City	42½ cents	Omaha	42½ cents
Birmingham	45 cents	Rochester	11½ cents

Methods of Wrecking Concrete Building

Description of Methods and Cost of Wrecking a One Story Reinforced Concrete Building

BY ALBERT M. WOLF, C. E.

Wrecking concrete buildings with the aid of dynamite is rather novel in this country, but quite common in Europe, especially on isolated structures. The concrete industry is still too young to make the removal of concrete buildings a common thing, but the time is no doubt coming when methods of razing such structures will engage the attention of the structural engineer much more frequently. For this reason a description of the methods employed in razing a one-story reinforced concrete beam and girder building should be of especial interest and value.

Fig. 1. General View of Building.

In the course of construction of a new boiler house at one of its plants the Consolidated Gas, Electric Light and Power Co. of Baltimore was confronted by the problem of the rapid removal of a one-story reinforced concrete building of the girder and slab type containing approximately 300 cu. yds. of concrete.

Fig. 2. Breaking Up Slabs and Drilling Holes in Column Bases for Dynamite Charges.

This building, which had never been completed, consisted of 35 columns supporting girders on column centers which in turn carried a concrete slab reinforced with ⅜-in. round bars, 5-in. centers. In addition to this, there were several ash hoppers and concrete partition walls which had to be removed. These are shown in Figure 1, which is a view of the building a few days after starting operations.

A majority of the columns, twenty-three in number, were 24 in. square, reinforced with eight 1-in. round bars, tied at 1-ft. intervals with ties or hoops. The remaining twelve columns were rectangular in shape, 12x36 in., in section reinforced with eight 1¼-in. round bars with ties at 1-ft. centers. The girders and bins were heavily reinforced and the concrete partitions also contained some reinforcement. The structure was erected nearly six years previous and the concrete was therefore very hard, and difficult to break up.

A local contractor was awarded the contract with the provision that the entire work be completed in 20 days. This time, however, was slightly exceeded, since a total of 23 working days was required to finish the job.

The work of wrecking and breaking up the various portions of the building was carried on in the following manner:

The floor slabs and ash hoppers were broken up by laborers wielding heavy sledges, starting at the middle of panels and working toward the girders, stripping the concrete from bars as they proceeded. On account of the comparative thinness of these slabs this work was done in a short time. Figure 2 shows the men breaking up the slabs and other groups drilling holes in bottoms of columns for dynamite charges used to displace them.

Light charges of dynamite were placed at bottoms of columns and in girders at the top. These were set off

Fig. 3. Firing Blast at Base of Column.

simultaneously, the columns and girders falling to the ground, where they were broken up either by hand or with the aid of dynamite. In some cases more than one shot was necessary to drop the columns and girders. Figure 3 gives a good view of a blast at the bottom of a column and Figure 4 the appearance of the base after the discharge of the dynamite, the column bars being forced outward off the steel column base on which they rested. This construction of columns no doubt facili-

Fig. 4. Appearance of Column Base After Blast.

tated the work of wrecking, for had the column bars extended into the footings sawing off the bars would have been necessary. The footings of the structure were not removed, but all other debris was used for filling at another point on the property.

COMMENT

The cost to contractor of razing this structure was about $1,200.00, or about $4.00 per cubic yard. This method of demolition of course can be used only on isolated buildings or on those where the adjacent buildings are of such a type as will not be damaged by the explosions.

The writer is indebted to Mr. Jay C. Lathrop for photographs and data used in making up this article.

NEW BOOKS

STRUCTURAL ENGINEERING. By J. E. Kirkham, Professor of Structural Engineering, Iowa State College. Cloth, 6x9 inches; 669 pages, many line drawings, tables and full page plates. Published by The Myron C. Clark Publishing Co., Chicago. Price, $5.00.

A book treating of simple structures, designed as a textbook for college students and as a self-explanatory manual of structural engineering for practical men. The author promises a second volume on "Higher Structures," which will treat of movable bridges, cantilever, arch and suspension bridges, secondary stresses, etc.

Within the past few years a considerable number of books on structural engineering and its various phases have been written, but very few of them covering the subject in such a complete manner as Prof. Kirkham. One feature to be commended is the inclusion of a chapter on elementary mechanics which makes the book more complete in itself, and which is necessary with the average student even after his courses in theoretical mechanics and mechanics of materials.

The first chapter presents definitions and methods of design and fabrication procedure. An interesting but rather short chapter on drafting follows. The next three chapters deal with the fundamental elements of structural mechanics and the theoretical treatment of beams and columns. Chapter 6 deals with the theoretical principles of rivets, pins, rollers and shafting. The purely theoretical portion of the book is completed with chapters on maximum reactions, shears and bending moments on simple beams and trusses, and stresses in trusses; grapical statics and a short but well arranged exposition of the use of influence lines in determining reactions, shears, bending moments and stresses in trusses. The remaining five chapters treat of the detail design of I beams and plate girders, simple railroad and highway bridges, and buildings; and a theoretical chapter on skew bridges, bridges on curves, economic height and length of trusses and stresses in portals. A set of tables, including a table of moments for Cooper's E-40 loading and the usual tables of properties of beams, channels and angles.

In the chapters on design, the theoretical formulae governing the design of any part of a structure are first given followed by numerical examples illustrating its use. This no doubt is the best method to follow in a textbook provided, of course, that the presentation does not adhere to one particular method of doing each thing, since in order that the student will not blindly follow a given path, he must have laid before him the different methods used to do the same thing with the limitations and advantages of each. In other words, the idea should be to enhance the judgment of the student as to proper methods of design for particular cases, rather than to teach him hard and fast rules to be followed without judgment. This Prof. Kirkham has done for the most part in a noteworthy manner.

The large detail drawings illustrative of different classes and parts of structures are in general excellent. The use of single angle kneebraces for wind bracing and beam stiffening connections in tall steel buildings as shown in the illustrative plate is not in accordance with the best practice in office building design and detracts from the treatment of the subject.

The book is well arranged, the typography is good, and the line drawings with a few exceptions clear and distinct. As a text and reference work this book will no doubt find a welcome place among other excellent works on structural design.

MASONRY. By M. A. Howe, Professor of Civil Engineering, Rose Polytechnic Institute. Cloth, 6x9 inches; 160 pages, illustrated. Published by John Wiley & Sons, New York. Price, $1.50.

As the author states, this is a short text-book on masonry construction written to furnish a concise treatment of the subject for use in courses of instruction which do not provide sufficient time for the study of a more comprehensive treatise. Reinforced concrete or foundations are not treated on account of the numerous books on the former subject and because the author's book, "Foundations," treats the latter.

The subject matter includes chapters on natural building stones, artificial building materials, stone masonry, brick and hollow-tile masonry, concrete masonry, specifications and a list of valuable references to other books and periodicals for more extensive reading and study of the various subjects which in this volume are given in more or less of an outline form.

The book is well written and illustrated and although a very brief sketch of the broad subject of masonry, no doubt will find a valuable place in schools and colleges desiring a short text book.

Terminal Improvements, Canadian Pacific, Vancouver, B. C.,

Passenger, Freight and Steamship Terminal Recently Completed. Passenger Station of Steel Construction.

Owing to the rapid growth of traffic at the Vancouver terminal of the Canadian Pacific Railway, in British Columbia, it became necessary about two years ago to provide increased facilities for handling both passenger and freight business. This rapid growth of traffic has been due very largely to the transcontinental service of the C. P. R., its steamship service between Vancouver and the more important Pacific coast ports and its trans-Pacific service to and from ports in Japan, China, Australia and the Philippines. Another element that has served to increase this business has been the various other steamship lines with which the transcontinental trains connect at Vancouver. This interchange of traffic between the railway and steamers as well as between the city of Vancouver and other points necessitated somewhat unusual terminal provisions.

The general layout of the terminal improvements, indicating the relative locations of the railway passenger station, steamship wharves, viaducts and local freight yard is shown in Fig. 1. It will be noted that the passenger station is located at the foot of Granville street, one of the principal thoroughfares in the city. This street has been extended over the passenger and freight tracks to a new steamship pier. To the west, at Burrard street, another viaduct has been constructed over the tracks to afford access to the steamship pier used for trans-Pacific service, built in 1908 and which has since been extended out to the harbor line. This extension was made to provide for the larger steamships which were put into service within the last two years. The site of the old passenger station was directly at the foot of Granville street, and the only means of access to the steamship piers before the improvements were made was by way of a grade crossing to the west of the old station. This grade crossing naturally was a source of danger and delay, and in the new plan the freight yard was rearranged with connections to reach the present steamship piers as well as those which might be constructed at some time in the future when business required.

The passenger track layout provides four through tracks, raised about five feet above the old grade in order to reduce somewhat the vertical distance between the street level and the track level. Provision has been made for an extension of the trackage by leaving room for additional passenger tracks to the north over the site occupied by freight tracks. The station building facilities are adequate to serve several times the number of passenger tracks built under the present plan.

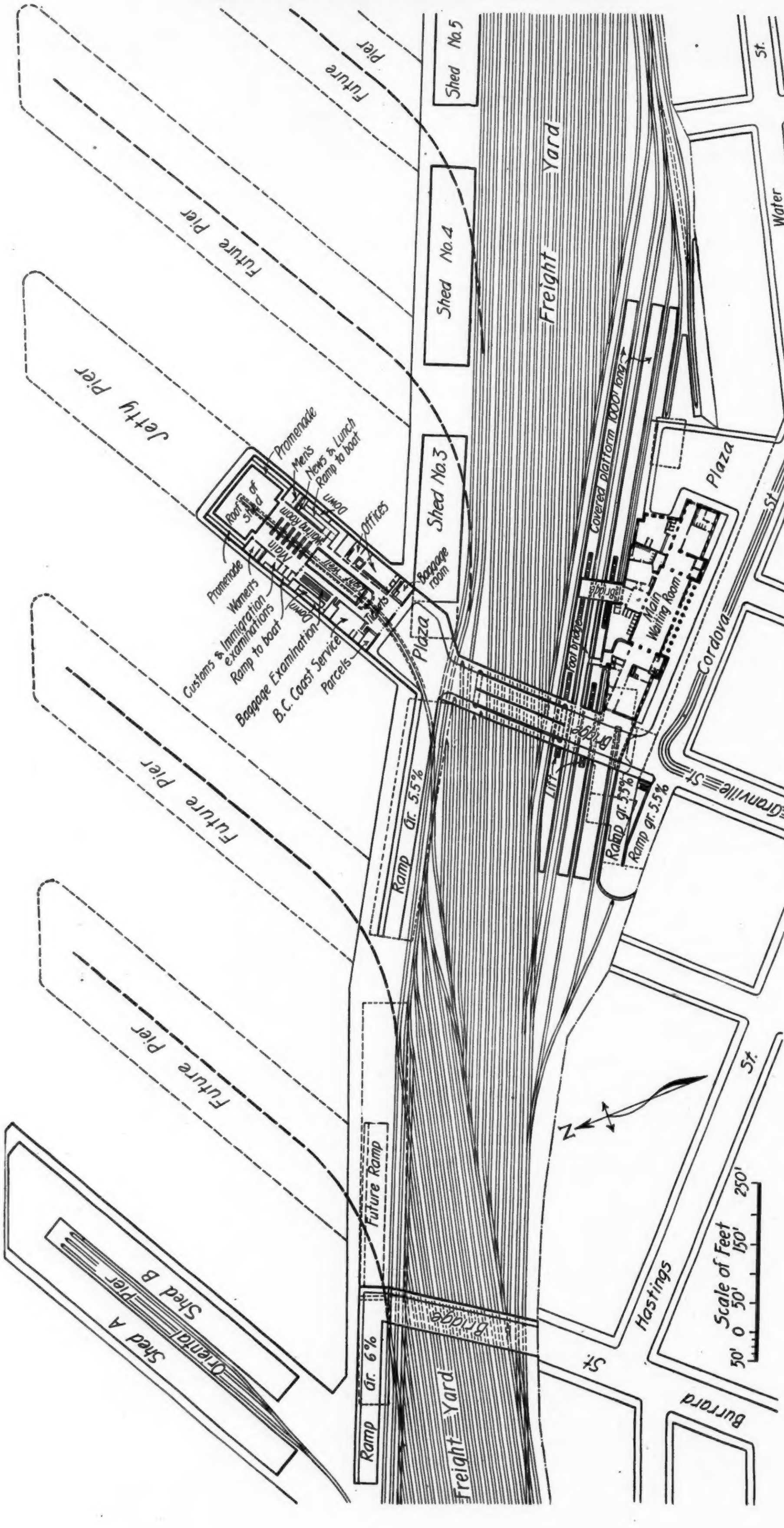
THE PASSENGER STATION

Granville and Cordova streets were about 35 feet above the old level of the tracks. Under the new scheme these streets are about 30 feet above the track level. This condition necessitated the use of a two-level station with the principal public rooms on the street floor and railway facilities for baggage, express, etc., on the track level below. The plan also lends itself to providing a convenient means of access to the train platform and shelters by a bridge over the tracks. Independent exits are provided, so that passengers may go directly to the street without passing through the station. Electrically operated baggage lifts are provided by which baggage may be raised from the platform level to the extension of Granville street and thence carried to the steamship pier. On the street level of the station are the general waiting room, ticket offices, lunch room, women's waiting room, smoking room and baggage checking room, all conveniently located with relation to each other and with generous allowance for lobbies and corridors. On this floor also are the principal entrances to the C. P. R. offices, which are located on the upper floors. A plan of the ground floor is shown in Fig. 2. The general waiting room is 212x56 feet, including the east and west lobbies, each of which measures 46x28 feet. The women's waiting room and the smoking room are each 46x36 feet. On this floor also are located the lunch room and its service pantry. The kitchen and refrigerating rooms are placed on a mezzanine floor below the street level. On the track floor are the baggage, mail and express rooms; also rooms for Canadian and United States customs, warerooms for the news and dining-car departments and the power plant. Steam is generated for heating the station and cars and other service facilities are provided. Between the station building and Cordova street, at the lower level, is a large paved area used for baggage, mail and express trucks. Access to this area from Cordova street is had by a ramp descending by easy grades to the west of the station building.

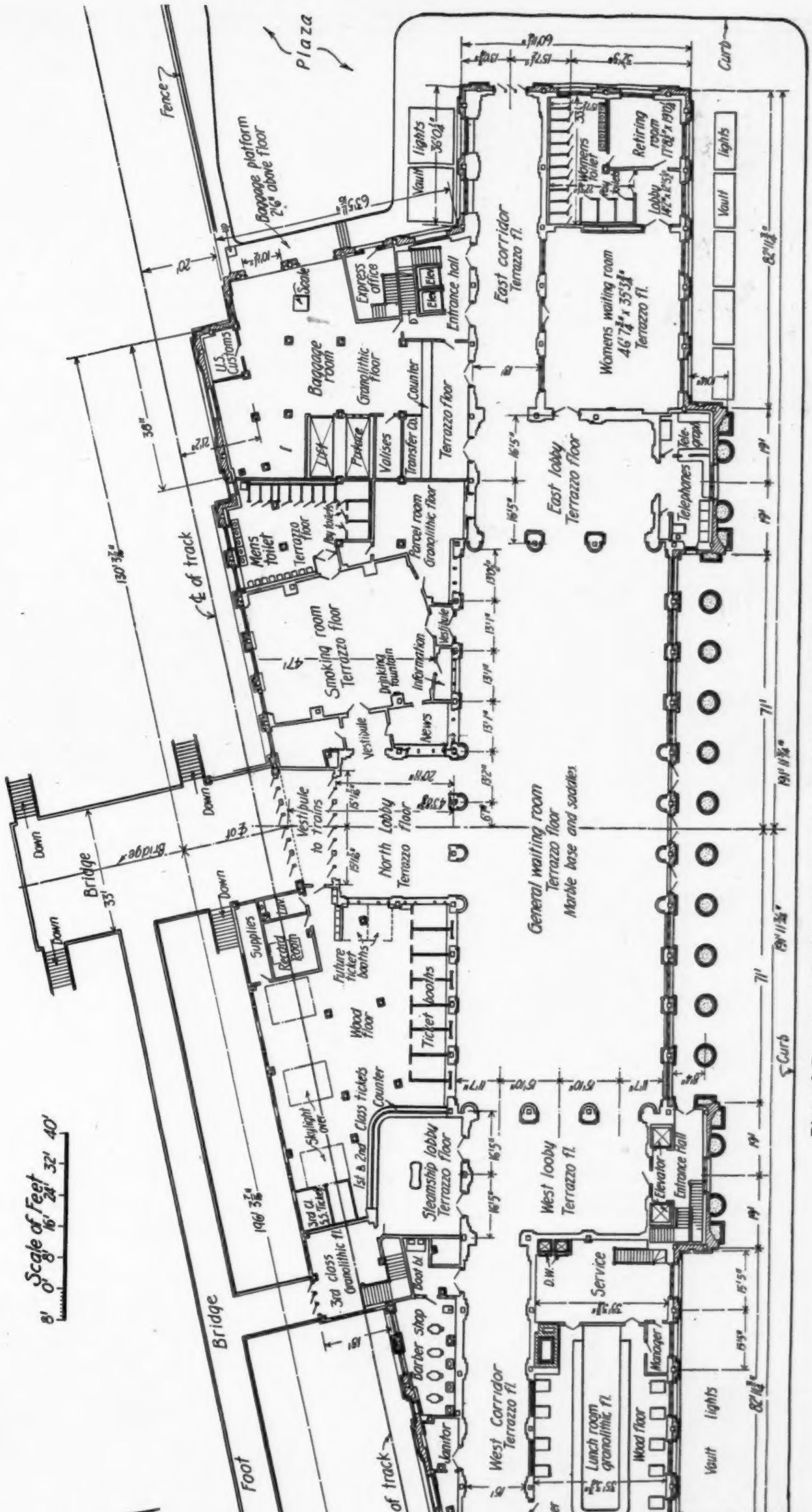
The passenger station is a steel-frame structure with pressed brick exterior walls and Indiana limestone trim. The main facade of the building consists of a colonnade of ten free-standing ionic columns, 35 feet high, symmetrically flanked by pavilions or end wings. The track facade of the building is expressed by a series of large arched openings and occupies a very conspicuous position when viewed from the harbor. This facade is shown in Fig. 3. Fig. 4 shows the Cordova street front of the station and Fig. 5 the general view of the main waiting room. This room is located immediately behind the colonnade and is approached by vaulted corridors from either end of the building. Ionic pilasters and engaged columns are used for the decoration of the walls of this room. These columns are of artificial Caen stone with walls tinted to match the stone work. The floors are of Terrazo figured with a design paneled to match the arrangement of seats and wall columns. The ceiling is 40 feet above the floor and of heavy beam and panel design. Illumination is by means of incandescent electric lamps, the ornamental ceiling fixtures and wall torches of special design being of cast bronze. The seats in the main waiting room and woodwork around the ticket office are of oak. The smaller waiting rooms, dining room, etc., are treated in a very simple manner with oak wainscoting, plaster walls and plain panel ceiling.

Above the ground floor are three floors devoted to offices for the use of the railway company. A large interior court affords natural lighting for the general waiting room and also for the interior office rooms. These offices are finished in natural wood with maple floors. Four passenger elevators serve the office quarters and the lower mezzanine and track-level floors.

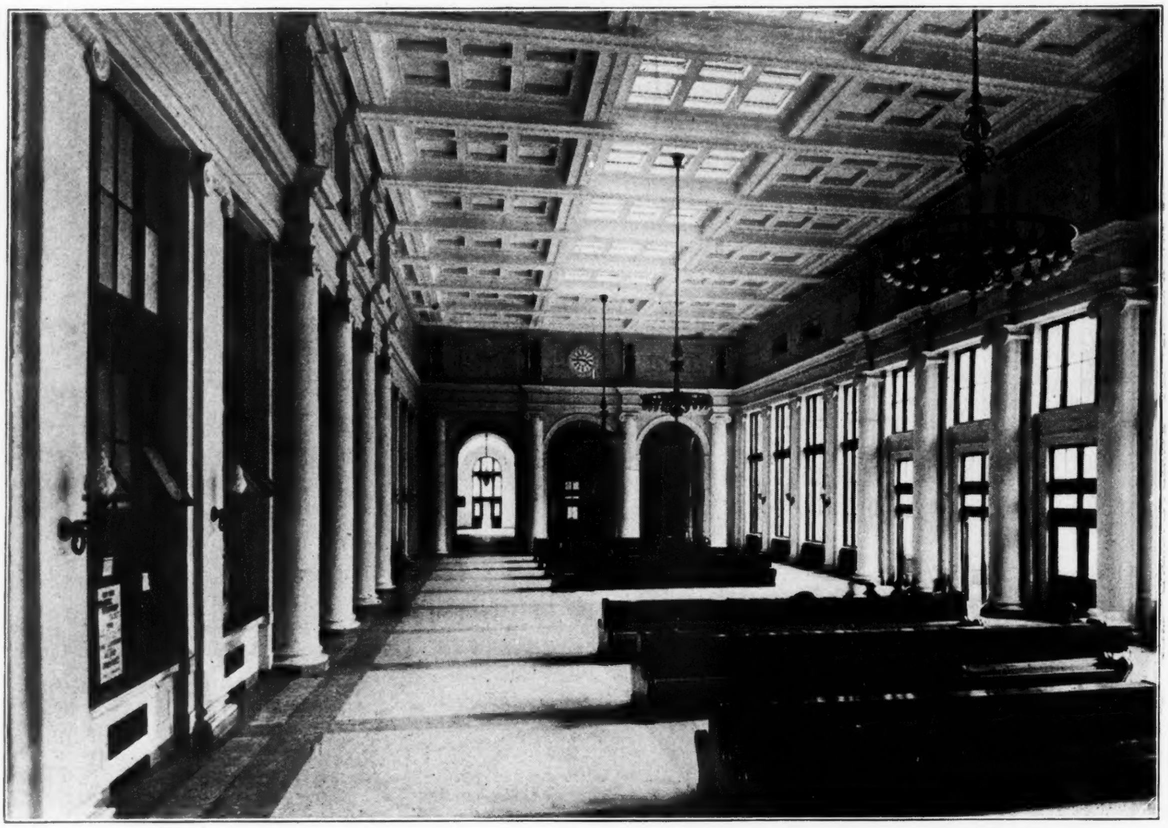
The service plant, located on the track-level floor, has a capacity of 450 horsepower. The boilers are of the horizontal return tubular type, designed for oil fuel, and they supply steam for the forced circulation hot-water



Plan of Freight Yards, Passenger Station and Piers, Vancouver Terminals, Canadian Pacific.



Plan of Passenger Station, Vancouver Terminals, Canadian Pacific.



Main Waiting Room, Vancouver Terminals, Canadian Pacific.

heating system in the railway station, also for passenger and freight car heating and for the steamship passenger station, which is heated by a direct steam system. A 12-ton refrigerating plant provides service for the lunch room and kitchen.

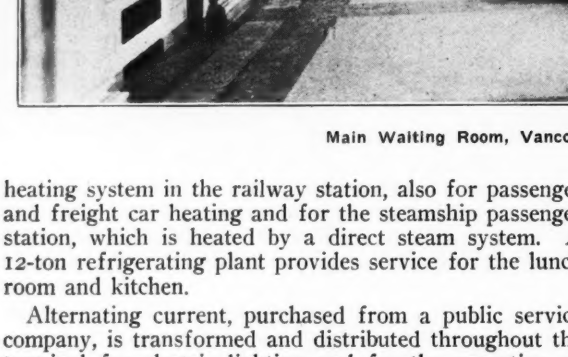
Alternating current, purchased from a public service company, is transformed and distributed throughout the terminal for electric lighting and for the operation of the elevators in the building and on the track level. Ventilation of the kitchen is accomplished by means of a supply and exhaust fan system. All toilet rooms are provided with an exhaust system. Vitreous china and porcelain plumbing fixtures are used throughout. For fire protection the two lower floors of the building have a sprinkler system. The upper floors are served by standpipes and fire hose.

A vacuum cleaning system, consisting of a six-sweeper low-suction machine operated by a direct-connected motor, serves all parts of the building above the track level.

Two tracks are provided for inbound passenger trains and two tracks for outbound passenger trains with separate platforms. There is a platform adjoining the station used for baggage, mail and express only. While Vancouver is the end of the line, the station is arranged as a through station, in order to get the best use of the tracks and avoid blocking the approaches when trains are backed out preparatory to shifting to the storage yards. Incoming trains proceed westward and back out over the thoroughfare in the freight yard, leaving the station tracks clear of all shifting movements.

THE STEAMSHIP PIER.

The extension of Granville street by a viaduct over the tracks affords access to the upper level of the new steam-



Passenger Station, Vancouver, Canadian Pacific.

Storage House for Dining and Sleeping Car Supplies, Vancouver Terminals, Canadian Pacific.

Passenger Station, Sheds and Portion of Freight Yards, Vancouver Terminals, Canadian Pacific.

ship pier. This viaduct is 80 feet in width and is enlarged in front of the pier station to provide a plaza for public and private vehicles. Baggage and freight are received at the pier on the lower level, to which access is had by ramps leading from Granville street and Burrard street viaducts.

The substructure of the pier is built largely of creosoted timber, and presents a number of unusual features. Sea worms, the toredo navalis, are very active in the waters of Burrard inlet, and untreated timber cannot safely be used for more than two years where called upon to bear heavy loads. The depth of water at high tide at the outer end of the pier prior to construction was over 60 feet, with a soft bottom, necessitating very long piles. The harbor was filled in at the site of the pier as high as was practicable, so as not to interfere with the draught of vessels which would use the pier, and the piling was then driven through the filling. About 3,000 piles were driven in the substratum, these piles ranging in length from 80 to 110 feet. The substructure of the pier is well braced above the low-water line and the filling referred to adds additional stiffness to the entire structure. Fenders of large logs chained together afford extra protection to the pier and distribute evenly throughout the structure any shock which may occur from a vessel striking the pier. A railway track, depressed so as to bring the floor of the cars about level with the pier floor, is carried through the center of the pier. The decking of the pier is of Australian hardwood, which has been found to give best wearing results with the class of traffic and atmospheric conditons existing in Vancouver.

The superstructure is slow-burning timber frame construction, covered with wood sheathing. The interior trim in the public rooms on the upper floor is of Douglas fir finished to show the natural grain and beauty of the wood, the exposed roof trusses in the main waiting room being dressed and chamfered. The waiting room is 82x96 feet. A ladies' waiting room, a smowing room and rooms for the immigration and customs departments of Canada and the United States have been provided. There is a promenade overlooking the harbor, reached from the waiting room, on the outer end of the pier over the one-story freight structure. As one enters from the plaza the ticket office, parcel room and baggage checking room are conveniently reached on the concourse leading to the main waiting room.

Access to the steamships from the upper level is afforded by means of ramps leading from the concourse, on easy grades to the landing on which the gang planks are placed. The landing is adjustable for different stages of the tide, which has a range of about 16 feet. Passengers coming from the steamships use the ramps and go through the customs examining rooms, or, where examination is not necessary, they may be diverted directly into the concourse. On the lower level, which is used for baggage, express and freight, there are provided electrically operated lifts on each side of the pier to meet the vessel ports. These lifts are adjustable, and may be used as sloping gangways or raised and lowered similarly to an elevator, and are 10x48 feet in area, holding several trucks at one time.

DINING-CAR STORES.

Certain facilities were provided for the terminal outside of the area shown in Fig. 1. Among these is a building for the dining and sleeping car department, which is completely equipped with facilities for storage and distribution of supplies, a bakery and kitchen, refrigerating apparatus, rest rooms and offices for conductors, porters and other employes. The building is a two-story structure with brick walls and heavy timber interior frame, with laminated floors. The building is located conveniently to the passenger car yards where the cars are cleaned and overhauled between service periods on the road. Fig. 7 shows the dining-car building.

The general designs and layout of the entire work were prepared, terminal buildings constructed and equipment installed by Westinghouse Church Kerr & Company, Montreal and New York, under the general direction of the engineering department of the Canadian Pacific Railway, Mr. J. G. Sullivan, chief engineer. The architects for the passenger station building were Messrs. Barott, Blackader & Webster, of Montreal. Work was begun early in 1912, and the station and pier were opened to the public in July, 1914.

THE ST. PAUL TERMINAL EXIT.

The nine railroads that enter St. Paul and had decided to build a new $15,000,000 Union Station, have killed the plan. The larger roads which would have had to stand the principal cost, it is said, decided that it would be unfair to their stockholders at such a time to make so large an investment. Perhaps if the Minnesota legislature had not voted down the proposed repeal of the 2-cent fare law, the action would not have been so promptly taken. The station, it is said, will be built eventually but not for several years or until the railroads can make much better earnings.

Labor Problem at the Balt. & Ohio Timber Preserving Plant

Detail Account of the Difficulty of Procuring Good Labor and Showing Cost of Handling Ties. By C. C. Schmatterbeck, Managing Editor, Wood Preservers' Bulletin

At the Baltimore & Ohio Railroad Company's Timber Preserving Plant at Green Spring, West Virginia, on the Cumberland Division—the busiest traffic section of the system—there are employed between 200 and 300 men, most of whom are pieceworkers. They handle about one million ties a year for treatment.

The labor situation at this plant is peculiar and it offers a good opportunity for the economist and sociologist to ventilate their theories on the service and comfort of a class of laborers that ordinarily do not work on the railroad.

By birth, or habitual wandering, the unskilled laborer applying for work at the Timber Preserving Plant claims to be an American, a German, a Frenchman, an Italian, a Scandinavian, an Austrian, a Pole, a Russian, in fact an offspring of nearly every nationality.

Many of these laborers are illiterate, and the dominant characteristic is their indifference as to their future welfare; they live for the present and work when it pleases them. Generally they are wanderlusters and crave a constant change in occupation.

Physically many of these foreigners look as though they could toss a tie of 200 or 300 pounds with one hand and repeat the performance many times a day. A careful study of the individuality and skill of these tie handlers has developed some surprising views. It is not always the man of huge muscle and tall stature who can stand the hard work longest. Sometimes the small man with moderate muscle is the better worker and will stick longer on the job. He often exhibits greater mechanical ability than his Sandow co-worker and seems to be less awkward in handling the ties which measure 8½ feet by 7 inches by 8 inches.

There have been men employed at the B. & O. timber preserving plant whose appearance would indicate that they were physically unfit for the work, but when they have been put to the test it was proved that they had the dexterity to handle ties more rapidly and for a longer period than their better developed sidepartners. It is a significant fact that men with a rugged appearance will often quit the job before their supposedly weaker companions. Fatigue usually develops after a few days' work, and if the tie handler has not the skill he invariably is "done-up" before the week is around.

Amateur tie handlers have the failing of over-exerting themselves, for they strive to increase their earnings too quickly. They work nervously and will soon tire from their wasted energy. The experienced tie handler seems to use less exertion and goes about his work with ease. He knows just how to tackle a tie and his judgment in team work is quite a factor in running up a big day's score for both men.

For some time after commencement of operation at the plant (in May, 1913) labor was scarce and very unsatisfactory in character. Negroes were in the majority, and it must be confessed a good part of this class of labor was symbolical of the "scum of the earth." As a rule negro labor has proven to be unreliable. The negro will work when it suits his convenience, for he has neither ambition nor the stick-to-it-ive-ness which is characteristic of the better class of unskilled white labor. The negro generally thinks pay day is the beginning of a two or three days' holiday and the plant employing him may just as well shut down on pay day. His earnings are usually spent in riotous living, and when the negro has partaken too freely of poor mountain whisky he is a dangerous character and will "cut-up" anyone who dares to interfere with his unlawful celebration of pay day. When the intoxicated negro's fiendish energy has been spent he will fall asleep and it usually takes from 24 to 48 hours to bring him back to his senses. He will then return to work and it is necessary to humor and drive him alternately to accomplish the duties expected of him. Occasionally a good worker is found among the negro laborers and he will sometimes earn more in handling ties at the piecework rate than many a clerk in the railroad service.

It is not an unusual occurrence to see an industrious negro handle from 100 to 200 or even 400 or 500 ties per day, which at the piecework rate of 1½c per tie is equivalent to $1.50 to $7.50 per day; but the average earnings seldom exceed $2.50 or $3.00 per day. There are now comparatively few negroes employed at the B. & O. timber preserving plant. Austrians are preferred as they have the reputation of being among the best tie handlers that can be obtained. The Austrian is stockily built as a result of his rugged outdoor life, hard work and diet which consists largely of meat and potatoes. The Austrian is jovial and peaceful and seems satisfied to work hard so long as he earns enough to permit him to save for the inevitable rainy day.

In order to keep the Austrians at the tie plant it has been necessary to colonize them under a fellow countryman who has had this peculiar experience, but owing to the European war some of the Austrians have left to enlist under the colors of their native land.

Comparatively few Italians care to handle ties at a piecework rate for they can earn $1.75 per day at track work, a job on which they do not have to expend as much muscular energy as they would at the tie plant. To earn $1.75 per day at the tie plant a man must handle 117 ties which at an average weight of 225 pounds per tie would be equivalent to about 13 tons.

Americans as a rule do not continue long at the work of handling ties for they soon find the work too heavy and uncongenial. The American will sometimes hold on to his job as tie handler with the hope that he will eventually be given charge of a gang of foreigners whom he can boss at a regular daily wage.

Unskilled labor for the timber preserving plant at Green Spring is obtained through the Baltimore & Ohio free labor bureau and its correspondents at Pittsburgh, Chicago, St. Louis, Cincinnati and other leading cities. Usually an order is placed with these labor agencies for a certain number of tiemen to be furnished daily, this number varying with the requirements at the plant and is also influenced by the fact that only a few of the men sent remain to work. These laborers are usually shipped in gangs at the expense of the railroad company and each individual is tagged for indentification at destination.

When they arrive at the plant the laborers are requested to register at the office, but as many of them can neither read, write nor speak English, all are given a number and their names, as nearly as can be understood, are entered on the register by the clerk. It is surprising how many of these foreigners hesitate to acknowledge that they are married, but when it is learned that some of them have abandoned their families or are trying to evade arrest it will be understood why they wish to hide their identity. There are cases on record where deserted wives have

sought their erring husbands; a mother, her wayward son; an employer, a dishonest employee; a creditor, a debtor; a detective, a fugitive from justice; but the culprit usually manages to get away before he is identified.

It is encouraging to note that a better class of labor is now at work at the B. & O. timber preserving plant, for the men are beginning to realize that their occupation is permanent and the food and lodging cheaper and better than the average.

At the plant the unskilled labor is divided into three gangs, all pieceworkers, and each gang is in charge of a foreman. The Back Track Gang, consisting of 16 to 30 men, according to the number of green ties to be unloaded in the yard, are paid at the rate of 1½c per tie. Should the ties be checked (split) "S" irons are driven into them, and for this work the plant pays ¼c per iron. The men who drive the "S" irons earn good wages and their occupation is assured by the fact that during the seasoning of ties in the yard from six months to a year there is certain to be more or less checking, especially if the ties are of the softer woods.

The Back Track Gang not alone unloads green ties on the ground to season but also cribs them. The ties are cribbed seven on one—that is, placing one tie one way and seven the other, and a crib twenty tiers high contains 105 ties.

After the ties have been properly seasoned in the open air they are picked up and loaded on small tram cars. This work is done by the Truck Gang which is in charge of a foreman and consists of about twenty men who are paid at the piecework rate of 60c per tram. A tram contains an average of about 43 ties, and 15 of these trams constitute a retort charge. Between five and eight charges are run through daily, according to the rapidity of absorption of the preservatives. When the trams are loaded direct from the cars the men on the Truck Gang receive 65c per tram, which includes shifting the trams and sorting the ties as instructed by the foreman.

There are two retorts each 132 ft. 1¼ ins. long and have an inside diameter of 7 ft. The retorts have a dome 3 ft. by 3 ft. and a track upon which the tram cars containing the ties rest during the period of impregnation. Each retort weighs 168,520 pounds and has a capacity equivalent to 5,207 cu. ft. or 38,954 gals. in preservative solution. It requires two men to operate each retort door. To properly treat ties requires from five to eight hours, depending on the seasoning they have had; the longer the seasoning, the quicker the absorption of the preservatives and consequently the shorter the period of treatment. When treated the trams containing the ties are withdrawn from the retort by a narrow gauge locomotive and are pulled to the depressed loading platform where the Platform Gang loads the ties into the standard gauge cars for shipment. The loading of treated ties into standard gauge cars is done either by hand at the piecework rate of 45c and 50c per tram, according to the style of the car loaded, which includes stamping ties; or when loading is by means of the well known Angier tie loader the piecework rate is 45c per tram. This tie loader, invented by the superintendent of the timber preserving plant, will do the work of three men at a material saving in cost of loading treated ties. In construction the tie loader is simply an "L" shaped steel hook with teeth to prevent the ties from slipping. This hook is suspended by a chain from an overhead portable trolley which connects with the top of the box car to be loaded.

Loading treated ties into the cars from the ground or crib by hand is paid for at the rate of 1c to 1¼c per tie. Cribbing treated ties, however, is not a common practice at the B. & O. plant, and is only resorted to when the supply of cars for shipping out the treated ties is insufficient to meet the requirements. The piecework rate noted above for the Platform Gang includes all labor necessary to load cars, such as staking flat cars, standing ties upright around the ends of coal cars, switching tram cars and doing all other work requested by the foreman.

Loading cars with treated ties is a problem, and owing to their heavy weight and slippery nature (due to the wet creosote surface) it would be imprudent to try to load the cars in the same way as untreated ties. With the sharp curves and varying grades on certain points of the railroad it is necessary to use great caution in loading cars with treated ties. "Safety First" is the watchword of all employes of the B. & O. timber preserving plant. The standard gauge cars are therefore loaded to the safety point, which in many cases is about 85% of their stenciled capacity. A standard locomotive switches the cars from the yard to the main line, where they are attached to the regular freight trains.

In October of last year the attempt was made to adopt the bonus system of pay for the various gangs, the object being to encourage the tiemen to do more work in less time so as to handle expeditiously the largely increased number of cars of ties received for treatment.

The bonus system was discontinued in December, when the management requested that expenses be reduced to conform to the general plan of economy in operating the railroad.

Under the bonus system pieceworkers realized a very good income, some making more money than their foreman, and it should be stated that they accomplished the amount of work anticipated.

Recently adzing and boring ties for screw spikes was undertaken at the B. & O. timber preserving plant. A number of these ties have been treated and have been placed in track on the Magnolia Cut-off (see December issue of Engineering). Hand wood boring machines operated by compressed air are used, and the men show unusual skill in their work. The ties bored are all sawed hardwood.

One of the greatest difficulties in effecting a permanent working force at the B. & O. Timber Preserving Plant at Green Spring has been the absence of houses in which employees and their families may live. Some months ago an attempt was made to overcome this difficulty by constructing several cottages from old box cars that had ben removed from their trucks. Each cottage has been constructed of three box cars, two placed parallel to each other and separated for a distance equal to the width of both cars, this space being boarded up to make an additional room. The third car has been set back between the two parallel cars, making in all a living room, kitchen and two sleeping rooms. These box car cottages are so situated that there is sufficient ground around them to plant vegetables for food and flowers for decoration. The cottages are rented to the tiemen for a small sum.

In addition to these box car cottages and the boarding camp layout described below, two passenger coaches have been fitted up near the plant office for the accommodation of the clerks and unmarried men. The passenger coaches have been converted into five sleeping rooms, living room, kitchen and a comfortable reading room. They are electrically lighted, and there is running water and have steam heating coils to insure comfort during the cold weather.

A feature of the plant is the commissary, which is in charge of an experienced boarding house keeper, and there is also a bath house with sprays for hot and cold water. This camp is equipped with comfortable bunks, can accommodate 65 men, and the food is good.

The railroad company guarantees to deduct from the wages of the men any debt that is contracted for board

and lodging or commissary, providing the purchase of commissary has been approved by the foreman of the plant.

To keep a record of the meals an original brass check system has been introduced, and it is the custom of the manager at the end of the day to check his accounts with the plant office to avoid an accumulation of bad debts. No liquor is sold and gambling is prohibited on the property of the B. & O. Timber Preserving plant.

Owing to the ruling of the Interstate Commerce Commission, the manager of the camp is obliged to pay all transportation charges of his help and supplies. Previously the railroad company carried both free.

Fuel and water are furnished the camp by the railroad company without cost, and no rent is collected for the use of the box cars that have been converted into the boarding and lodging quarters of the camp.

It is worthy of mention that the railroad company has issued strict instructions in regard to boarding camps on its system. Ordinarily the foreman is held responsible for properly maintaining and policing all camp car bunk houses occupied by men under his charge. At the B. & O. timber Preserving Plant there are two special officers (regular employees), one on night duty, the other on day duty, and they maintain order. On other parts of the system the master carpenter, supervisor and section supervisor are expected to inspect the camps frequently to see that their men do not violate the regulations of the railroad company.

Whenever camp cars are set off their trucks for permanent use as bunk houses the railroad company requires that they be placed at an inconspicuous location away from the main track, station and dwellings. Sometimes, however, it is impossible to abide by this ruling, but the camp cars are generally located as specified and are well ventilated, neatly painted and kept in good repair. When the camp cars are located temporarily at a certain point the railroad company insists that they be placed on temporary tracks or on a back track away from the main line. When the camp cars are placed on an operated track ties must be set in or rails taken out to prevent freight or passenger cars from being run against the camp cars. Should it be necessary to locate the camp cars on a track next to the main track or running track, then the cars must be closed on the side next to such track. The use of ladders or walkways on the side of the cars next to such track is prohibited.

RAIL CREEPING

Causes of rail creeping are given by Mr. J. J. Bethune, roadmaster, I. C. R., Charlottetown, P. E. I., in a recent issue of the Canadian Government Railway Employes' Magazine: (1) The effect of gravity, from the top of the grade to a sag, together with the application of the brakes to the wheels on the down grade, is the first or aggressive cause. (2) Track laid without the proper spaces left at end of rails for expansion, this causing rails to creep in the direction of least resistance, if there were no trains running on it. (3) Track not properly buried in ballast to prevent ties moving sideways. (4) Spikes not driven down tight in contact with rail flange. (5) Slot spikes at joints getting worn out, and in some cases breaking off. (6) Joint bolts not kept perfectly tight. With the exception of the first cause, these can, by close attention, be, to a certain extent, remedied.

In order to prevent rail creeping, or at least reduce it to a minimum, track must be well ballasted and filled within one inch of top of tie, with good heavy gravel or broken stone ballast, tie properly spaced and placed at right angle with rail, spikes at intervals kept driven down with head in contact with rail flange, slot spikes kept in good condition and in place, track bolts kept tight, and I have found it a good plan where joint ties kept pushing down grade in light ballast to put short struts made of 2 x 3 spruce between ends of ties on the down grade side, for three or four spaces, in order to get the support of the side thrust of three or four more ties to assist joint ties. No doubt the best preventive and final one, with the other conditions I have mentioned being attended to, is to apply a good anti-creeper, of which there are many on the market. I am not in a position to recommend any particular kind, as my experience in the use of them is limited.

But there are some peculiarities about rail creeping that are difficult to solve. I have in mind a piece of track on my own division on a down grade of 1.4 per cent and curves of 9 degrees. On three miles there is only 3/10 mile of tangent altogether, made up of short tangents between curves. The right and left curvature about balances, track direction being about due east and west. This piece of track has in two years crept 18 in. more on the north rail than on the other. It would be reasonable to think that on a long simple curve that the outside rail would have a greater tendency to creep on account of the continual side friction of the wheels, but in the case I have mentioned, on account of the curves being about balanced, it is natural to conclude that the creeping would be about equal on both sides of the track. I would be pleased to have the opinion of some of your correspondents on this point. The only reason that I can see for this difference is that perhaps the heat of the sun in summer would have a better chance to strike the north rail during mid-day, especially in clay cuttings, where the south rail would be, to a certain extent, sheltered.

Prospects Good for Erie-Michigan Canal

It is stated on the authority of Col. W. V. Judson, member of the board of army engineers, that the building of a lake to lake canal from Toledo, O., to the southern shore of Lake Michigan is a feasible project and that the board will recommend the adoption of the Toledo-Gary route in preference to the northern route which terminates at Michigan City.

The estimated cost of the canal is $75,000,000 and the report will recommend that the canal be connected with the Calumet river and through that river with the Illinois rivers to the Mississippi river and Gulf of Mexico.

The board of army engineers, which has had charge of the work of making the survey, is enthusiastic over the proposed canal and will do all in its power to push plans for its construction to a successful issue.

Col. Judson estimates that if the government is required to buy all the right of way for the canal, build the bridges, of which there are 105 on the northern or Michigan City route, and also purchase harbor sites, the project would cost in the neighborhood of from $75,000,000 to $80,000,000. If the counties through which the canal passes shoulder the above expenses it is believed that the waterway can be built for from $55,000,000 to $60,000,000, including everything, from Toledo to Chicago.

In the opinion of Col. Judson, it will be necessary to construct a 300 foot aqueduct bridge across the Kankakee swamp, west and north of Rochester, on the southern route.

The survey work was most thorough, and the report has set out in detail things which must be observed closely by the board of army engineers. It will mean the canalization of the Maumee river between Ft. Wayne and Toledo, a question which has been discussed not only by federal authorities but by civil authorities as well.

Government Regulation of Railroads

Speech of Hon. Oscar W. Underwood, Delivered Before the Sphinx Club, New York City, March 9, 1915.

No great economic question is settled finally until it is settled right. To consider and decide the problems that confront the railroad world today, we must lay aside passion and prejudice, greed and desire, personal interest and political bias, and approach the solution of the problem from a judicial point of view, as seekers after the truth, with a determination to stand only for the right.

Let us not forget that the money invested in our railroads exceeds the public debts of the four greatest nations of the world. That from the standpoint of capital, the question presents itself as an investment of money.

Let us not forget that trade regards the railroads as its best customers; that the output of thousands of mines, furnaces, factories are required each year to supply the consumptive capacity of the great railroad systems of the United States.

Let us not forget that labor recognizes that the railroads employ a million and a half of men and pays a wage that approximates that of the embattled armies of Europe.

Let us not forget that in the end the public, either as passengers or shippers, must pay every dollar that is required to maintain and operate the great transportation system of our country.

Finally, let us not forget that commerce is the vital part of a healthy business development and that an efficient transportation system is as necessary to the life of commerce as the heart is to the life of the human body.

The railroads are the country's most important highways. Destroy the railroads as they exist today and you destroy our commerce and bring disaster to our people. Without their proper maintenance they will soon cease to exist. Unless you extend and enlarge our present transportation facilities the business development of our country must stop where it is today.

We have undertaken the problem of Governmental regulation of railroads and the Government will not turn back. Regulation of practices and rates is here, and here to stay.

But let us stand for wise and just regulation and not for ill-considered and dangerous regulation. We must regulate so as to insure all necessary railroad facilities both for the present and for the future.

As the public in the end must pay the bill, they are primarily interested in the railroads securing the money needed for their maintenance and development at reasonable rates and equally interested in seeing that it is wisely expended.

To regulate the freight and passenger rates of the railroads so that the rates may be both just to the invested capital and at the same time reasonable to the public is a secondary problem, but of scarcely less importance than the one I have mentioned first. Together they embrace the alpha and omega of the railroad problem of our day.

In the solution of these problems we must protect the rights of private property invested in the railroads and at the same time assure to the public fair and reasonable treatment in the movement of commerce of our country.

I have said that the fixed policy of our people was regulation by the Government of our railroad systems, and it is; for whether you agree with me or not you may as well accept my conclusion. Revolutions never move backward. If governmental regulation is unable to solve the vexed problems that confront us, the people will accept Government ownership of railroads as the next step ahead. It is, therefore, a matter of great importance that we should earnestly endeavor to reach a fair and reasonable solution of the problem of regulation at as early a day as possible.

The transportation problem is so closely interwoven into the business fabric of our people that governmental control in some way was inevitable from the beginning. In almost all countries the railroad question is one of first importance, and has been met in foreign lands either by governmental regulation or ownership; but in other countries the problem has not been as difficult of solution as in our own, due primarily to two causes: Our large population and vast natural resources located far inland and at great distances from water transportation makes railroad carriage indispensable, and industrial freedom could be guaranteed only by just regulation.

Another difficulty that hinders the solution of the problem here and is not met abroad is a political one. Our dual system of government greatly increases the difficulties and uncertainties that surround the problem before us. Our Federal Government and 48 State governments constitute the 49 masters that the railroads must obey. It has been said, "No man can serve two masters." All of the important railroads run through two or more States and are subject to different laws, rules, and regulations whenever a train crosses a State line.

It is true that our lawmakers and our judges have endeavored to differentiate between interstate and intrastate business, but the effort to do so had led to much confusion and to much litigation. In the passenger coach we find an interstate riding beside an intrastate passenger, and in the baggage car a package that will reach its destination within the State in which it was shipped resting against a parcel whose destination is across the State line. Consider for a moment that the one package is subject to the rule of one and the other must obey the mandate of at least three masters.

Low rates and adequate facilities are demanded by the public, but the granting of one is often the denial of the other. Adequate facilities very often require the expenditure of large sums of money. Low rates prevent the accumulation of surplus capital and lessen the borrowing power of the roads. The price of new facilities must always be the acquisition of new capital from some source. Without new railroad facilities, our commerce can not expand beyond our present limitations and trade has met a permanent barrier to its future development.

It is therefore the public and not the stockholder who must suffer most if our regulation policies are inadequate to meet conditions fairly, broadly, and safely; for the travelers and shippers must defray the cost of transportation and pay for incompetence in building, operating, and regulating. The tax paid by our people for freight and passenger transportation for the year 1912 amounted to $2,826,917,967, and the part of the gross receipts that went to the stockholders as dividends was $346,805,582, or 12 cents out of every dollar. In fact, 88 cents of every dollar paid by the public went for operating expenses, taxes, and interest before there was a cent for new facilities or dividends.

In the beginning the railroads denied the right of any Government to control what they were pleased to call their private property, but they overlooked the fact that the grant given them was to maintain a public highway

in which the public was as much interested, if not more so, than their stockholders. Step by step governmental regulation has advanced until today railroad corporations are controlled by the public in respect to every detail of their business, and this control has been accepted and recognized by their managers.

It can not be denied that public control has reduced the rates charged for transportation and abolished unjust discriminations given to favored shippers. No one now contends that localities, as well as shippers, should not be treated with equal fairness.

But the greater problem remains unsolved. Can the money be provided to expand and develop these great public works in a manner commensurate with the expanding needs of our commerce under the present systems of public control?

In recent years accumulated surplus of railroads have largely disappeared; dividends have been greatly reduced, and the ability to secure long-time loans at low rates of interest has passed away. Without cheap money for development, new facilities can not be obtained and low rates for transportation be maintained.

We must all give credit to the present system of regulation for the accomplishment of much good in the interest of the public, but those who are giving careful study to the railroad problems that confront us are bound to admit that our present system of regulation is breaking down, in so far as it has supervised the finances of our railroad systems with a view to allowing them to properly protect their securities that their credit may be maintained to aid in present and future development.

If railway investments can not be made attractive to capital, is not the Nation threatened with an inevitable breakdown of its transportation systems?

We can never have permanent prosperity in the country until our great problem of transportation is settled and settled wisely. There is no more difficult problem awaiting its solution ahead of us, and no more inviting field for the exercise of true statesmanship has ever faced our public men.

Let us concede without cavil that transportation and commerce can only advance when they go hand in hand. Let us inspire courage and give aid to those leaders who, not by chance but through merit, direct our industry, control our trade, and manage our finance. It is not enough for our Government to permit those men to rise from the prostration which has overtaken them and their affairs. It must occasionally assist them. We have reached the point on our way to social betterment where sound progressivism must recognize that the proper regulation of business requires that it must be sometimes helped and not always hindered; must be sometimes assisted and not forever stricken; that we must occasionally say, "You may," and not always "You shall not."

It is gratifying to know that the policies mentioned are responsive to natural growths and can be achieved without entrenching privilege and subsidizing trade. We need only to permit railways, traders, and bankers that economic freedom which is consistent with a wise and helpful regulation of all affairs and to give every citizen the national protection to which he is entitled, wherever he may rightfully be—at home or abroad—for our trade to gain its lost position and for our flag to be seen on every sea.

PERSONALS

H. I. Miller, chairman of the board of the Buffalo & Susquehanna R. R. Corporation, receiver of the Buffalo & Susquehanna Ry., vice-president of the Mexico North Western Ry., and of the Denver & Salt Lake R. R., has been elected also president of the Tennessee & North Carolina R. R., with headquarters at New York. Mr. Miller resigned recently as president of the New Orleans Great Northern R. R.

T. W. Evans, general superintendent of the Second district of the New York Central R. R., has transferred his headquarters from Syracuse to Buffalo, N. Y.

B. A. Worthington, formerly president of the Chicago & Alton R. R., has been elected president of the Lorain & West Virginia Ry., with office at Lorain, Ohio.

J. R. Stephens, chief engineer of the Missouri Pacific-Iron Mountain system, has been appointed assistant to the president, with office at St. Louis, Mo. This position has been vacant since the appointment of Alexander Robertson as vice-president in charge of operation.

A. C. Ridgway, second vice-president of the Chicago, Rock Island & Pacific, has been appointed chief operating officer for the receivers, with headquarters at Chicago.

John Kirk, superintendent of terminals of the Elgin, Joliet & Eastern Ry., at Gary, Ind., has been appointed superintendent of the Gary division, with office at Gary, and C. H. Doorley, assistant superintendent of terminals at South Chicago, Ill., has been appointed superintendent of terminals at East Joliet, Ill.

O. E. Selby has been appointed principal assistant engineer of the Cleveland, Cincinnati, Chicago & St. Louis Ry. and the Peoria & Eastern Ry., with office at Cincinnati, Ohio. J. B. Hunley has been appointed engineer of bridges and structures, vice Mr. Selby.

E. A. Hadley, assistant engineer of the Missouri Pacific-Iron Mountain system, has been appointed chief engineer, with office at St. Louis, Mo., succeeding J. R. Stephens, promoted.

J. A. Shaw, electrical engineer of the Canadian Pacific, at Montreal, Que., has been appointed general electrical engineer, with headquarters at Montreal.

H. B. Cartwright, acting assistant engineer of the Seaboard Air Line Ry., at Jacksonville, Fla., has been appointed assistant engineer, with office at Jacksonville, vice L. R. Hoyt, assigned to other duties.

F. M. Metcalfe has been placed in charge of the bureau of efficiency of the Northern Pacific Ry., with headquarters at St. Paul, Minn., vice Charles T. Banks, resigned.

Professor C. R. Richards, Acting Dean of the College of Engineering of the University of Illinois, recently made a tour of inspection of the leading schools of engineering throughout the east.

F. H. Newell, formerly director of the United States Reclamation Service, recently delivered a series of three lectures before the College of Engineering of the University of Illinois. His subjects were "Reconnaissance and Selection of Engineering Projects," "Organization of the Work," and "Methods and Results."

Professor Ira O. Baker has resigned as the head of the civil engineering department of the University of Illinois, after more than forty years of service. Professor Baker is succeeded by Dr. F. H. Newell, consulting engineer of the United States reclamation service, who has assumed his new position. The new head of the department is one of the founders of the United States Reclamation Service. He was director of that bureau and before coming to Illinois held the position of consulting engineer.

The officers elected by the board of directors are: President, George T. Smith; vice-president, George E. Long; treasurer, J. H. Schermerhorn; secretary, Harry Dailey; assistant secretary and assistant treasurer, Albert Norris.